US007404697B2

(12) **United States Patent**
Thompson

(10) **Patent No.: US 7,404,697 B2**
(45) **Date of Patent: Jul. 29, 2008**

(54) **HEIGHT-ADJUSTABLE PIPE PICK-UP AND LAYDOWN MACHINE**

(75) Inventor: **Carroll R. Thompson**, The Woodlands, TX (US)

(73) Assignee: **Technologies Alliance, Inc.**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 110 days.

(21) Appl. No.: **10/513,543**

(22) PCT Filed: **May 2, 2003**

(86) PCT No.: **PCT/US03/13767**

§ 371 (c)(1),
(2), (4) Date: **Aug. 25, 2005**

(87) PCT Pub. No.: **WO03/093629**

PCT Pub. Date: **Nov. 13, 2003**

(65) **Prior Publication Data**

US 2006/0104746 A1 May 18, 2006

Related U.S. Application Data

(60) Provisional application No. 60/377,431, filed on May 3, 2002.

(51) **Int. Cl.**
E21B 19/00 (2006.01)

(52) **U.S. Cl.** **414/22.58**

(58) **Field of Classification Search** 414/22.52, 414/22.54, 22.55, 22.57, 22.58, 22.61, 22.62, 414/22.65, 22.68, 22.69, 22.71, 232, 745.9, 414/746.1, 746.2, 746.4, 746.8, 339, 349, 414/742, 743; 175/52, 85; 52/116; 89/1.8, 89/1.801; 14/71.7, 71.1, 71.5, 72.5, 69.5
See application file for complete search history.

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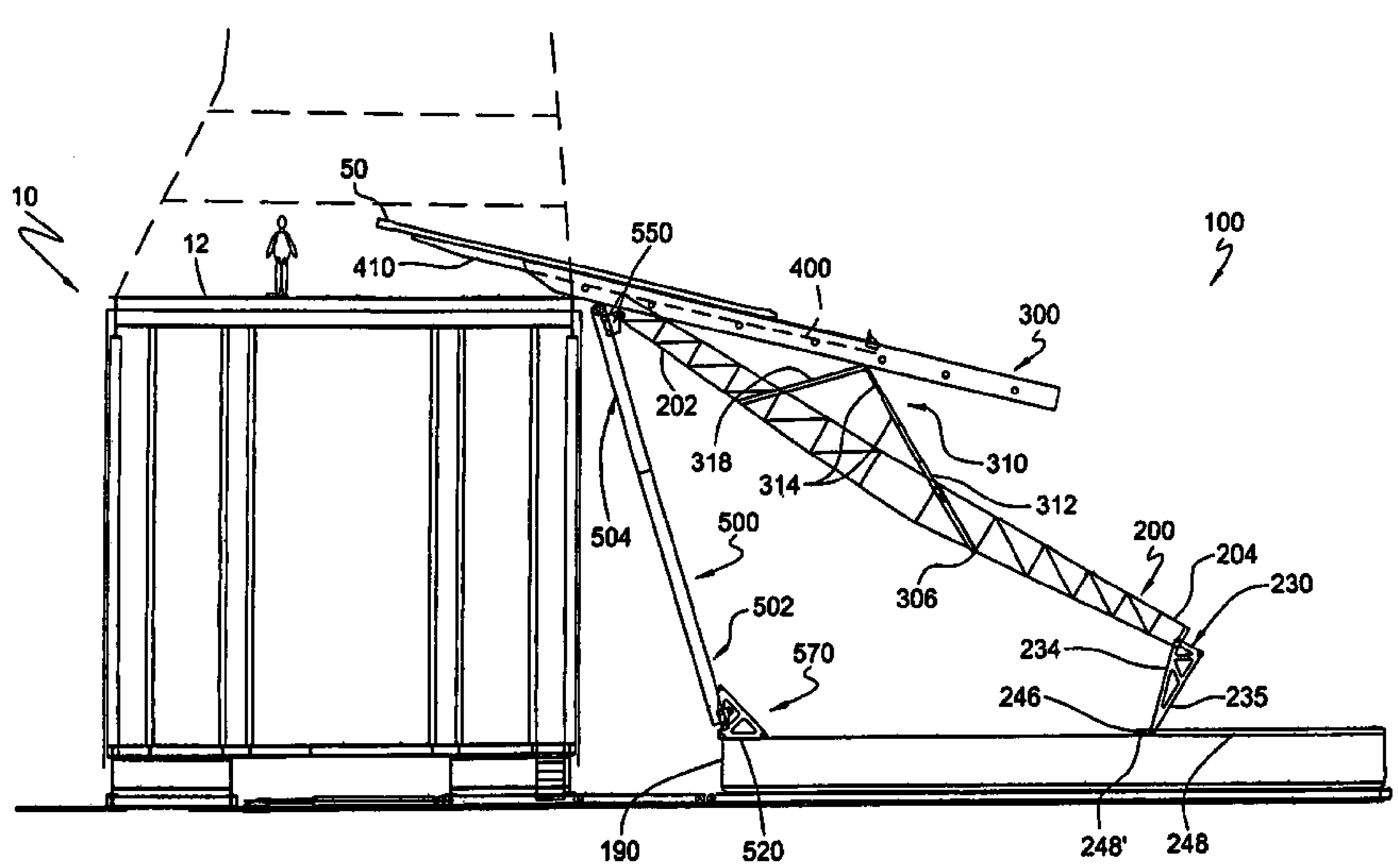
Primary Examiner—Saul J. Rodriguez
Assistant Examiner—Gregory W Adams
(74) *Attorney, Agent, or Firm*—Patterson & Sheridan, L.L.P.

(57) **ABSTRACT**

The present invention provides a pipe-handling machine (**100**) for picking up and laying down pipe, such as at a rig site. The machine first comprises three elongated and nested truss members. First, a trestle (**200**) is provided; second, a trough carrier (**300**) is received within the trestle; and third, a trough (**400**) is slidably received within the trough carrier. The machine next comprises an inclined ramp (**500**). A lower end of the ramp is pivotally connected to the trestle, while an upper end of the ramp extends upward to the rig floor. The length of the ramp is adjustable to accommodate rig floors of varying heights. A trestle transport mechanism (**550**) selectively moves a front end of the trestle upwards along the ramp, thereby delivering a joint of pipe to the rig floor. The trough may optionally be moved along the trough carrier and out over the rig floor to aid in delivery. Features (**310**) may optionally be incorporated to reduce the angle of approach of the joint of pipe relative to the rig floor after the trestle transport mechanism is actuated.

44 Claims, 31 Drawing Sheets



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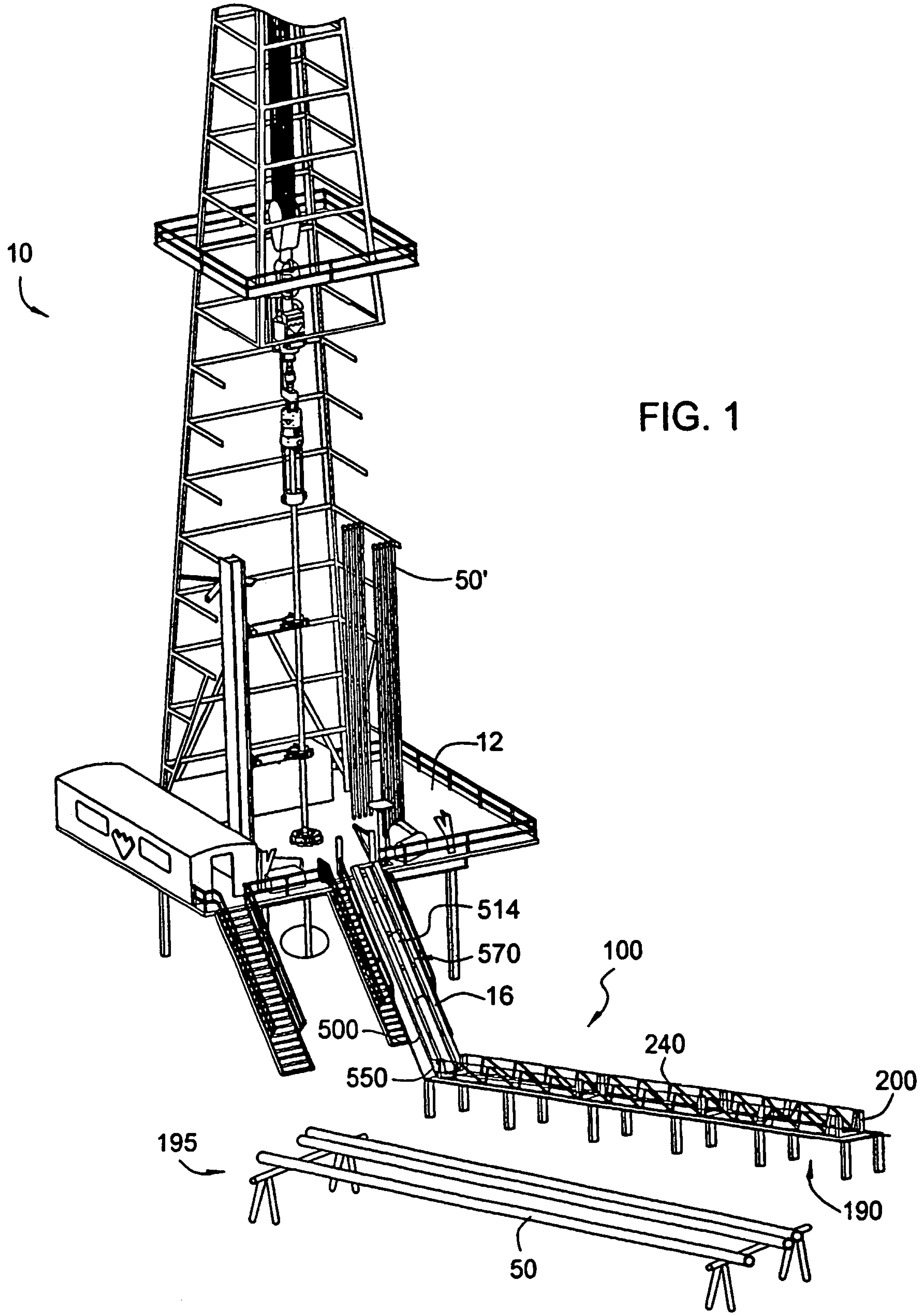
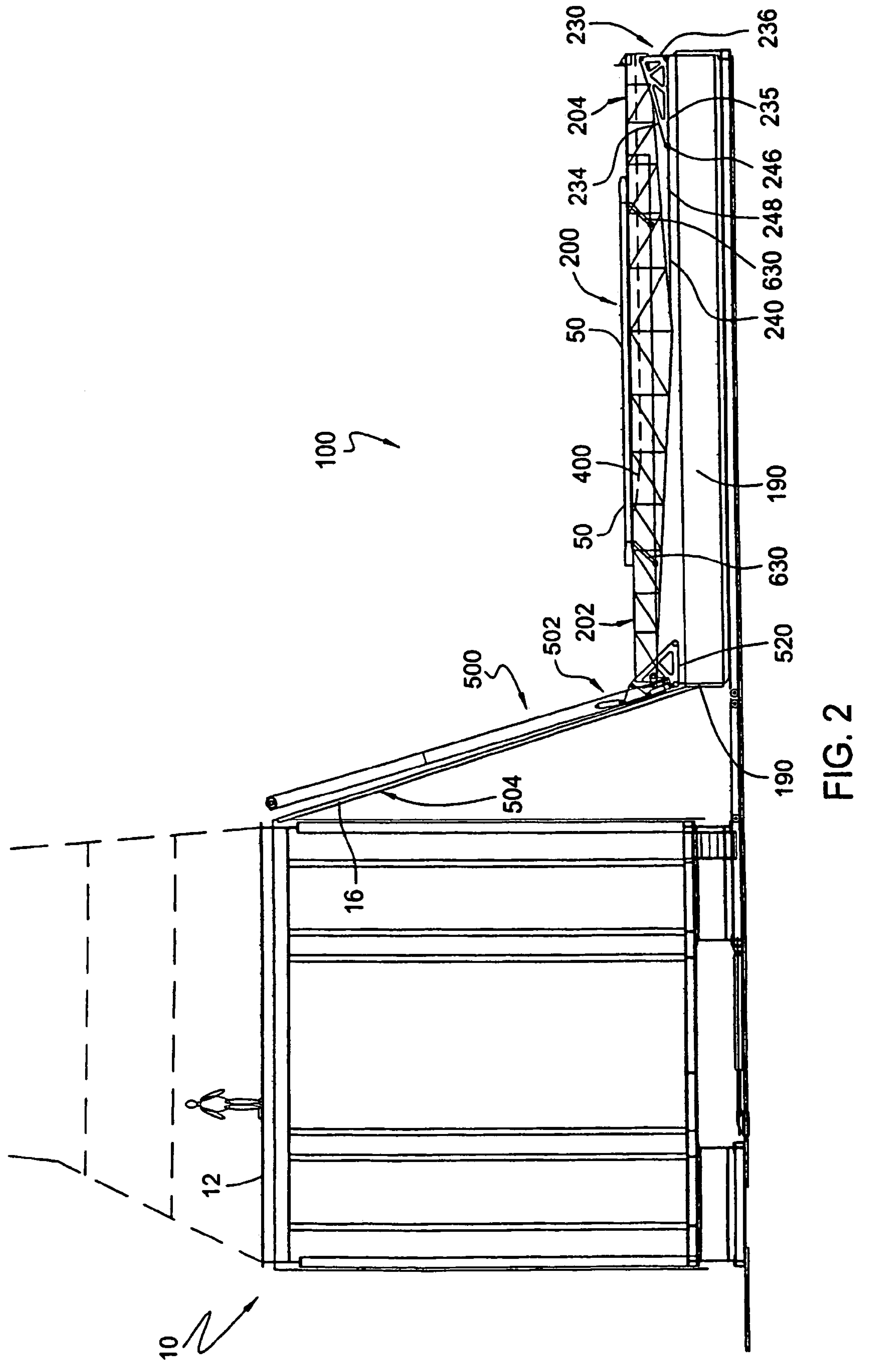


FIG. 1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204
235
234
246
248
200
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100
400
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50
630
502
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190
504
16
12
10

FIG. 2

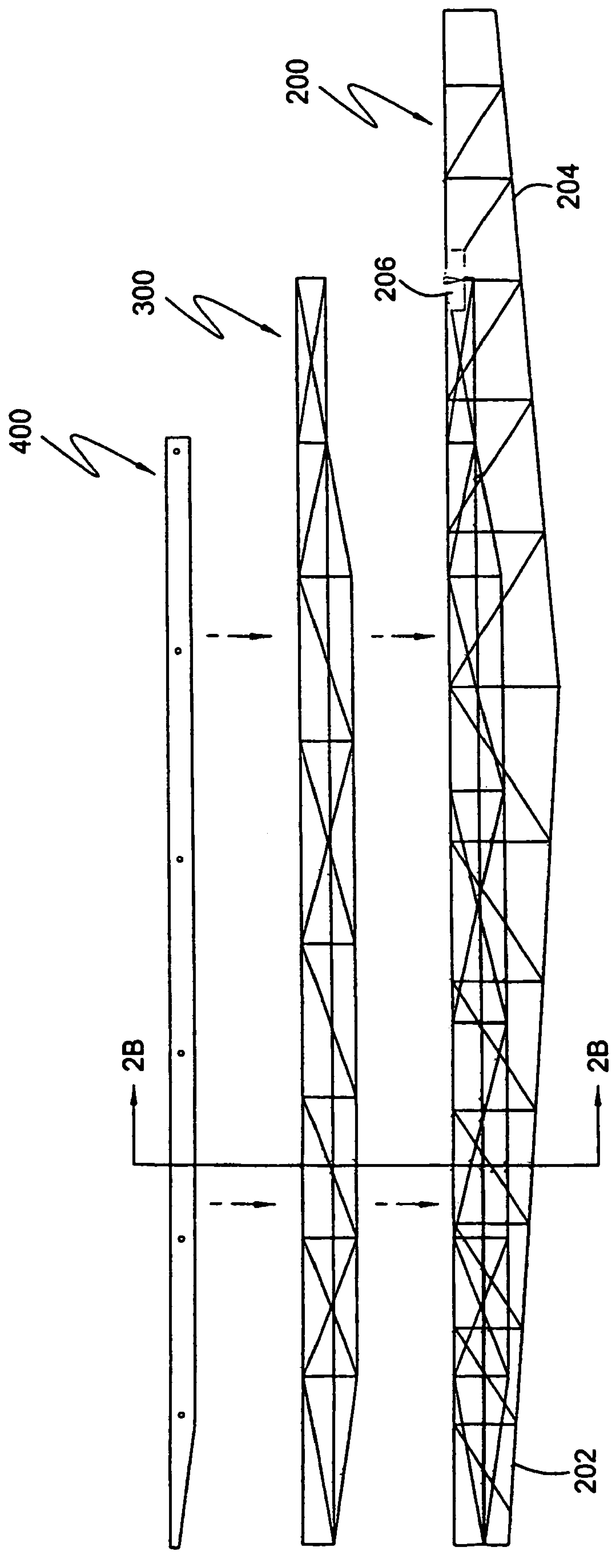


FIG. 2A

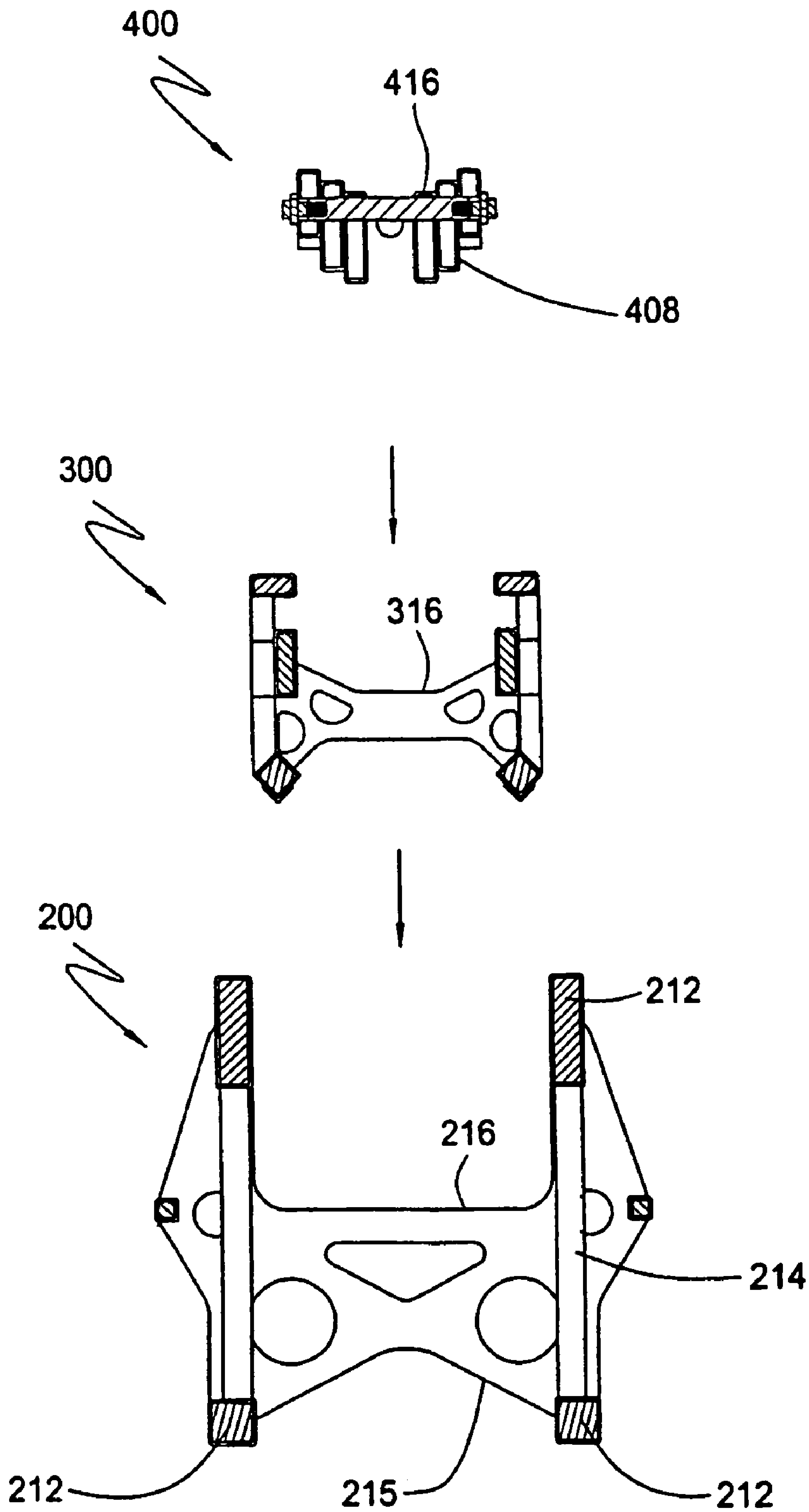


FIG. 2B

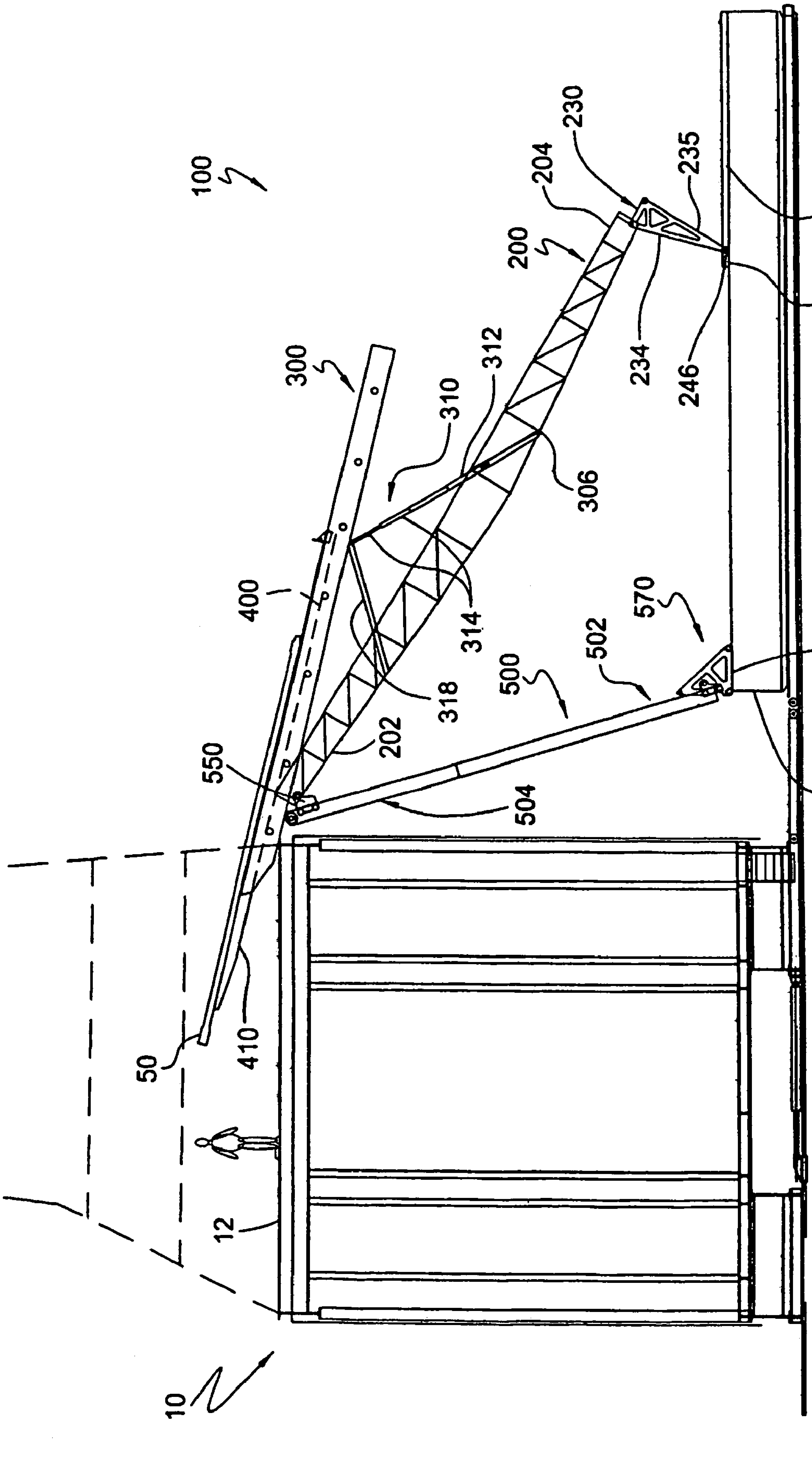

100
230
204
235
200
248
248'
234
246
300
312
310
306
400
570
502
314
318
500
520
550
202
504
190
50
410
12
10

FIG. 3

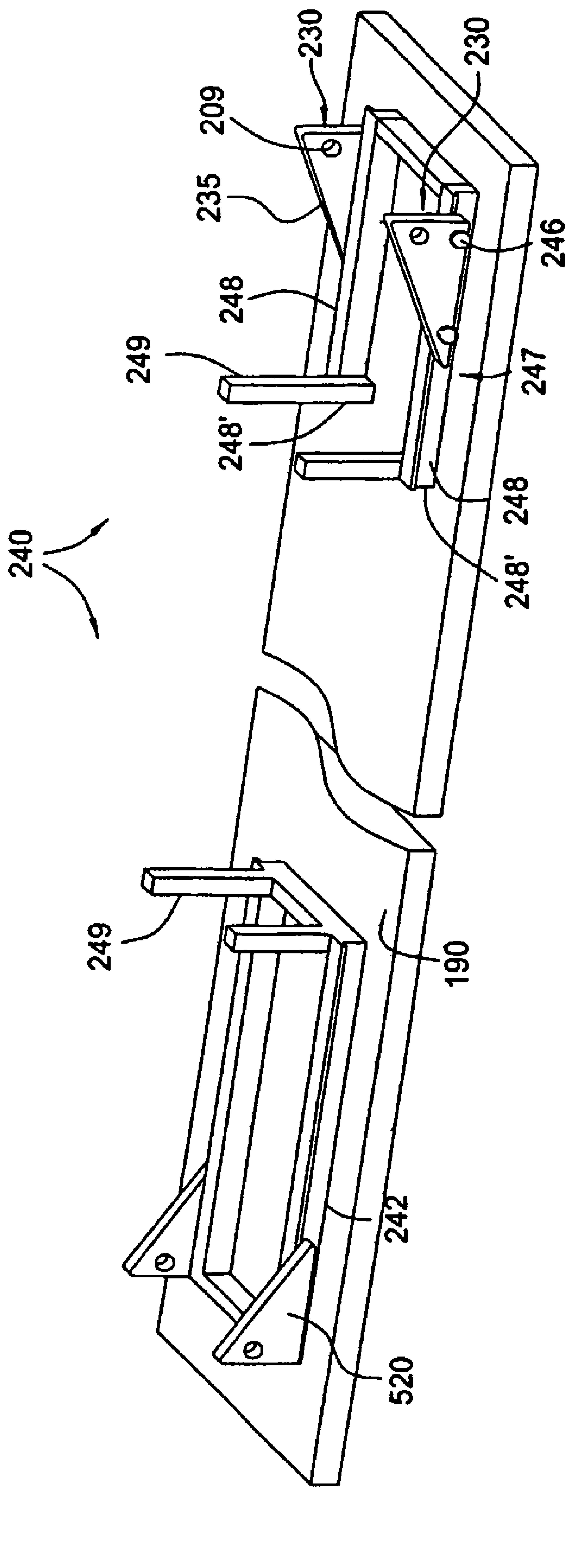
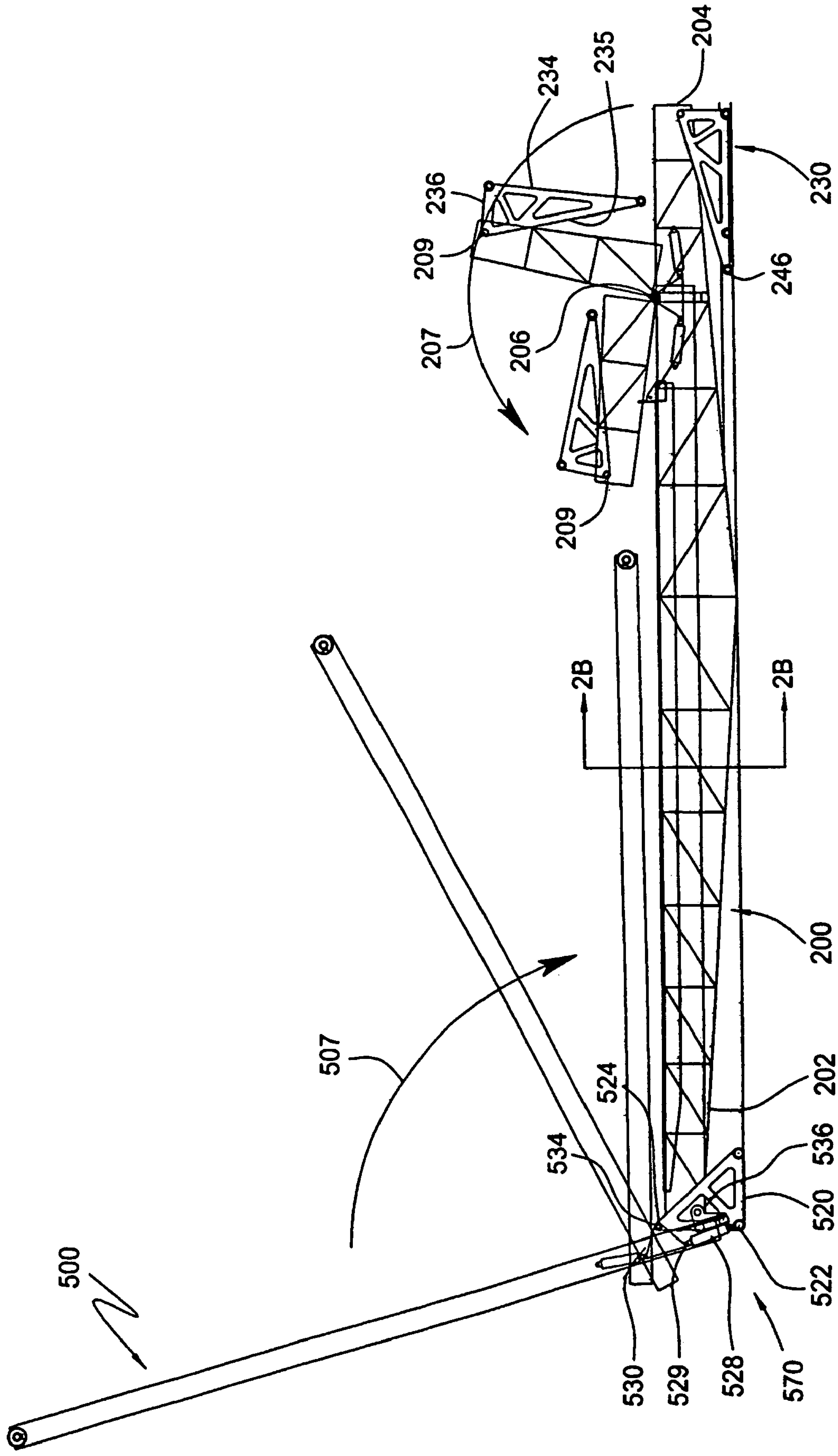


FIG. 4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235
234
236
230
209
246
207
206
209
2B
2B
200
507
202
524
534
536
520
500
522
530
529
528
570

FIG. 4A

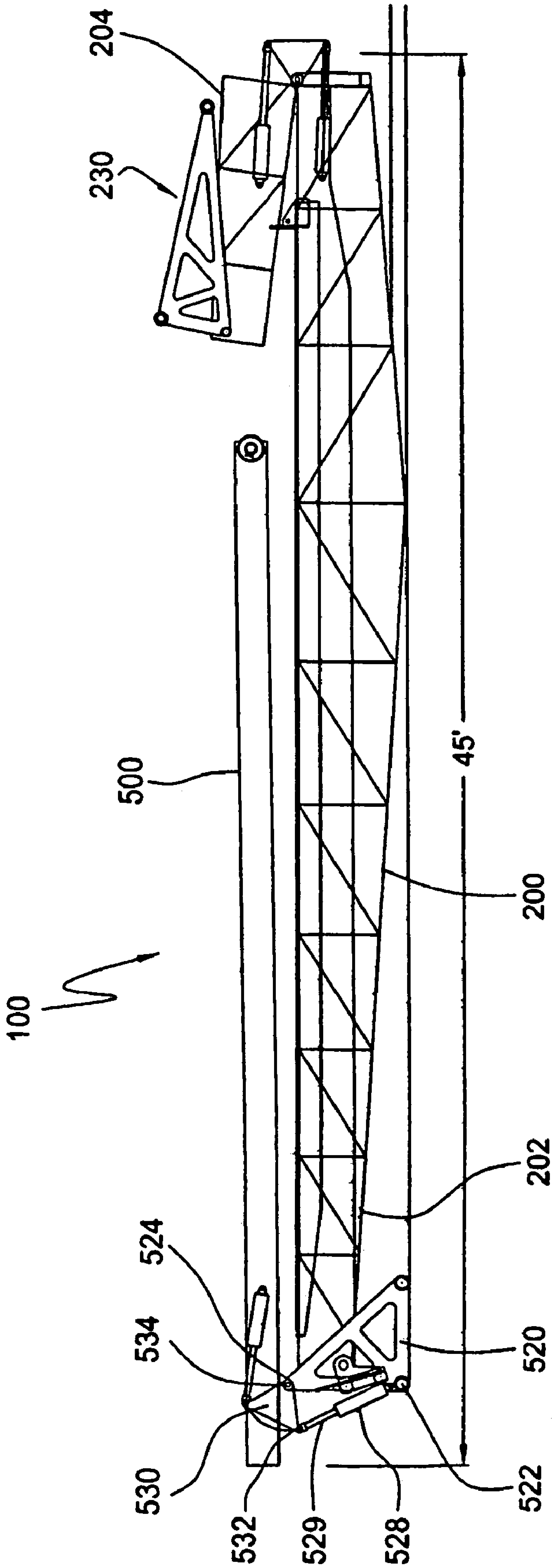


FIG. 4B

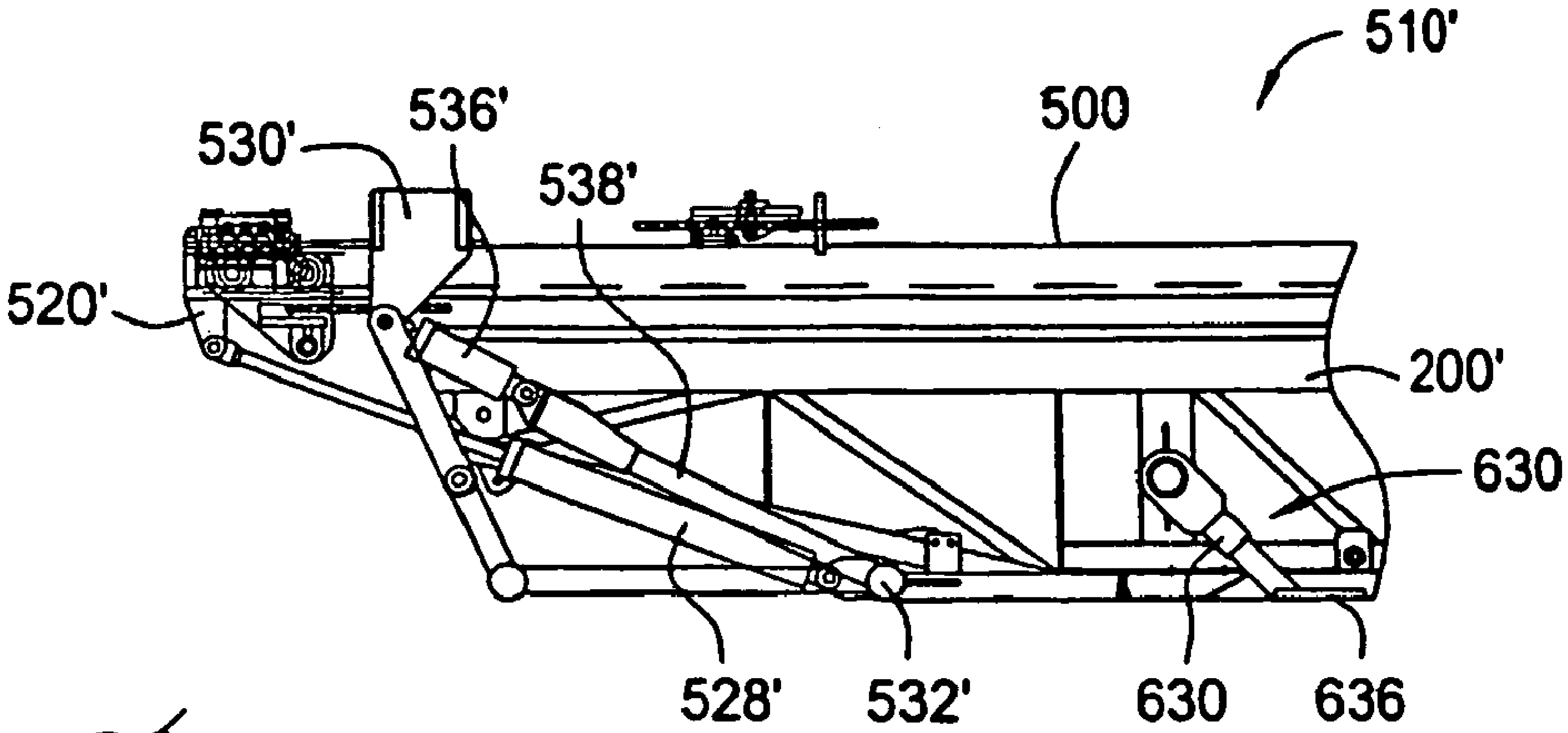


FIG. 4C (1)

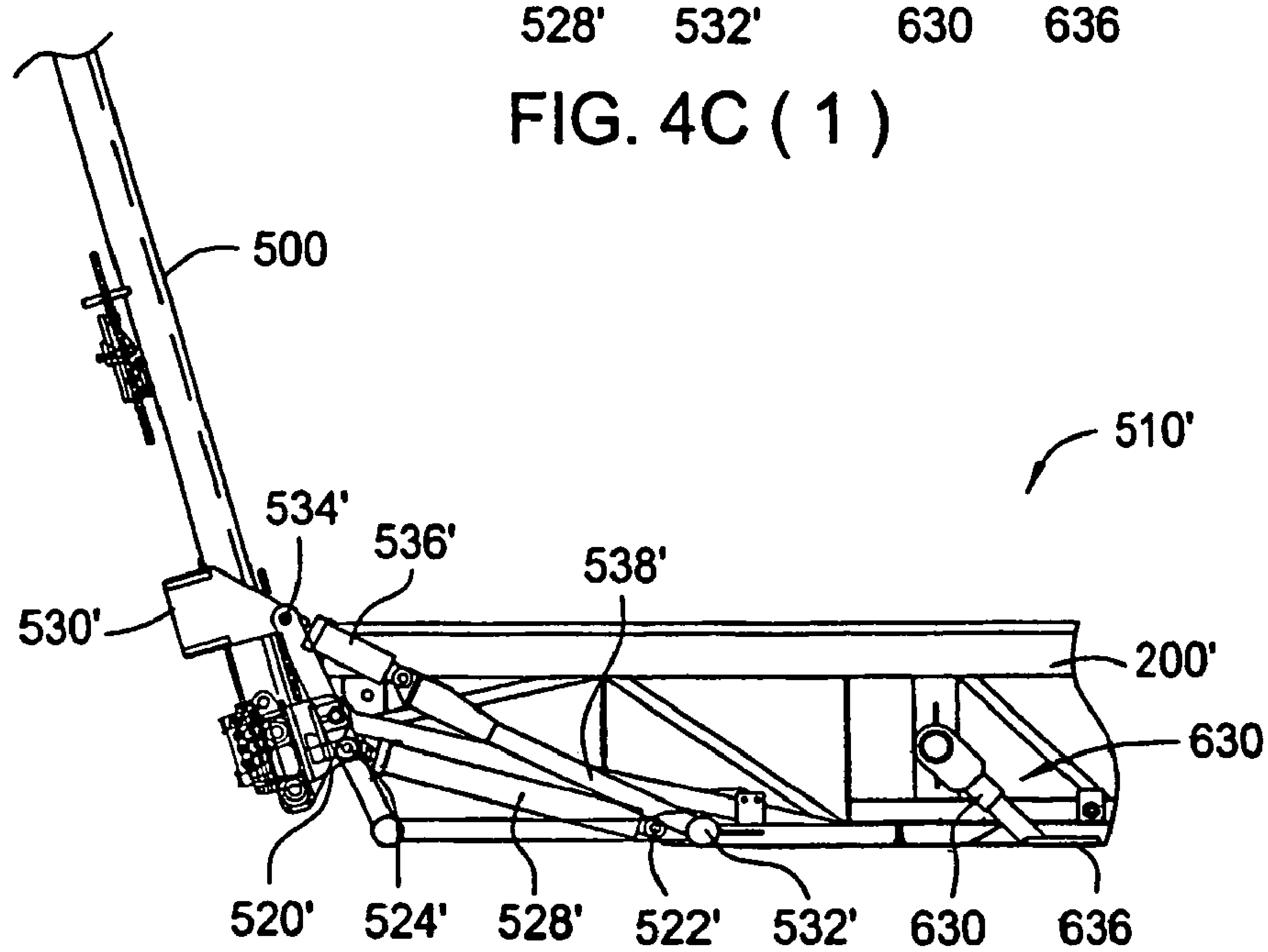


FIG. 4C (2)

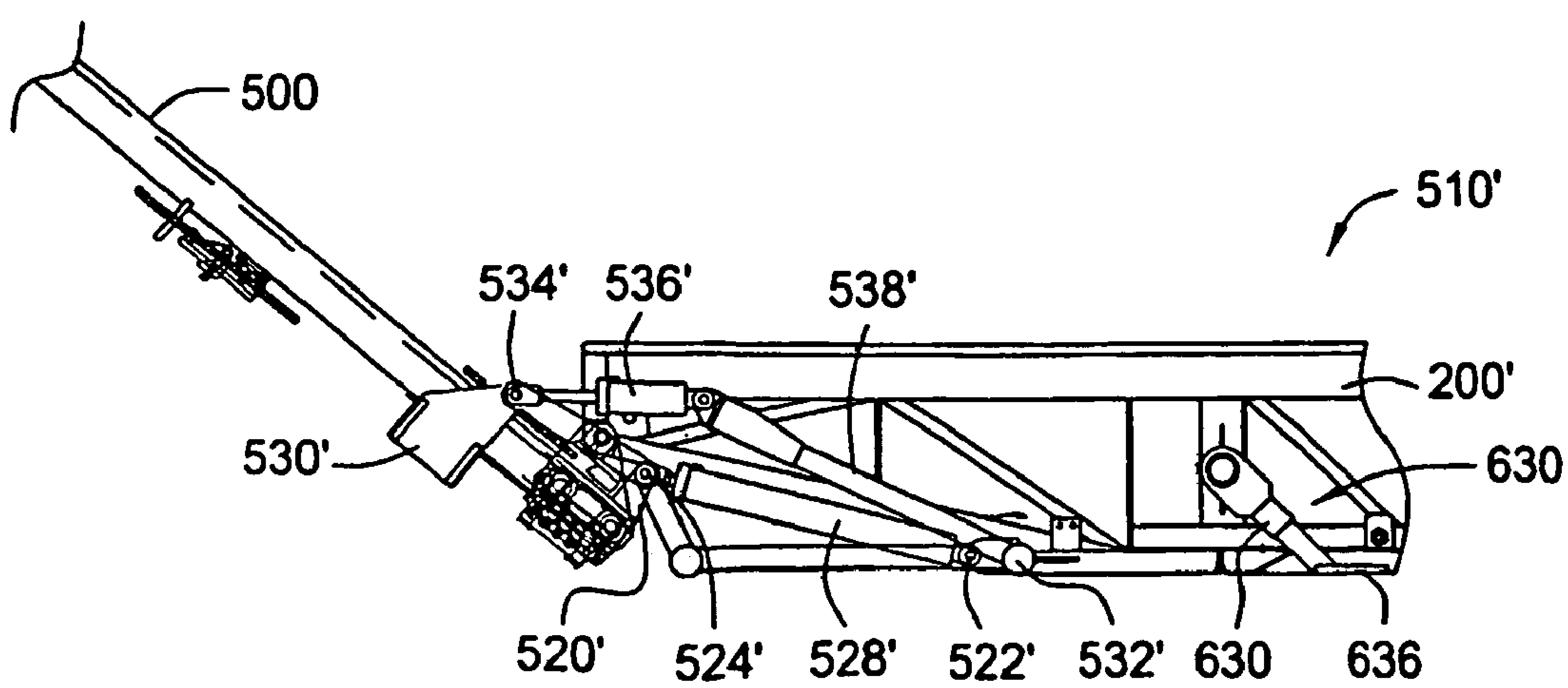


FIG. 4C (3)

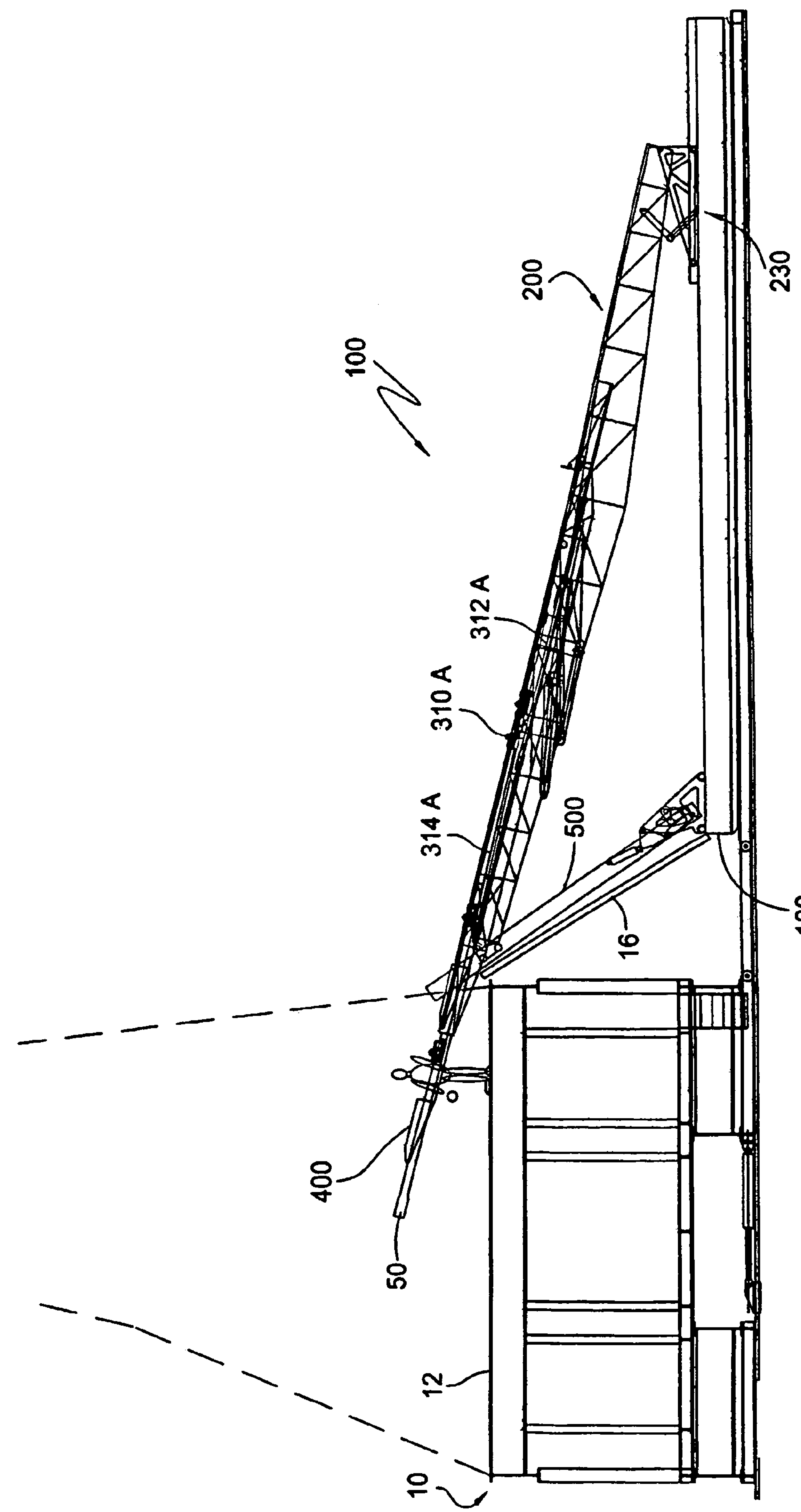


FIG. 5A

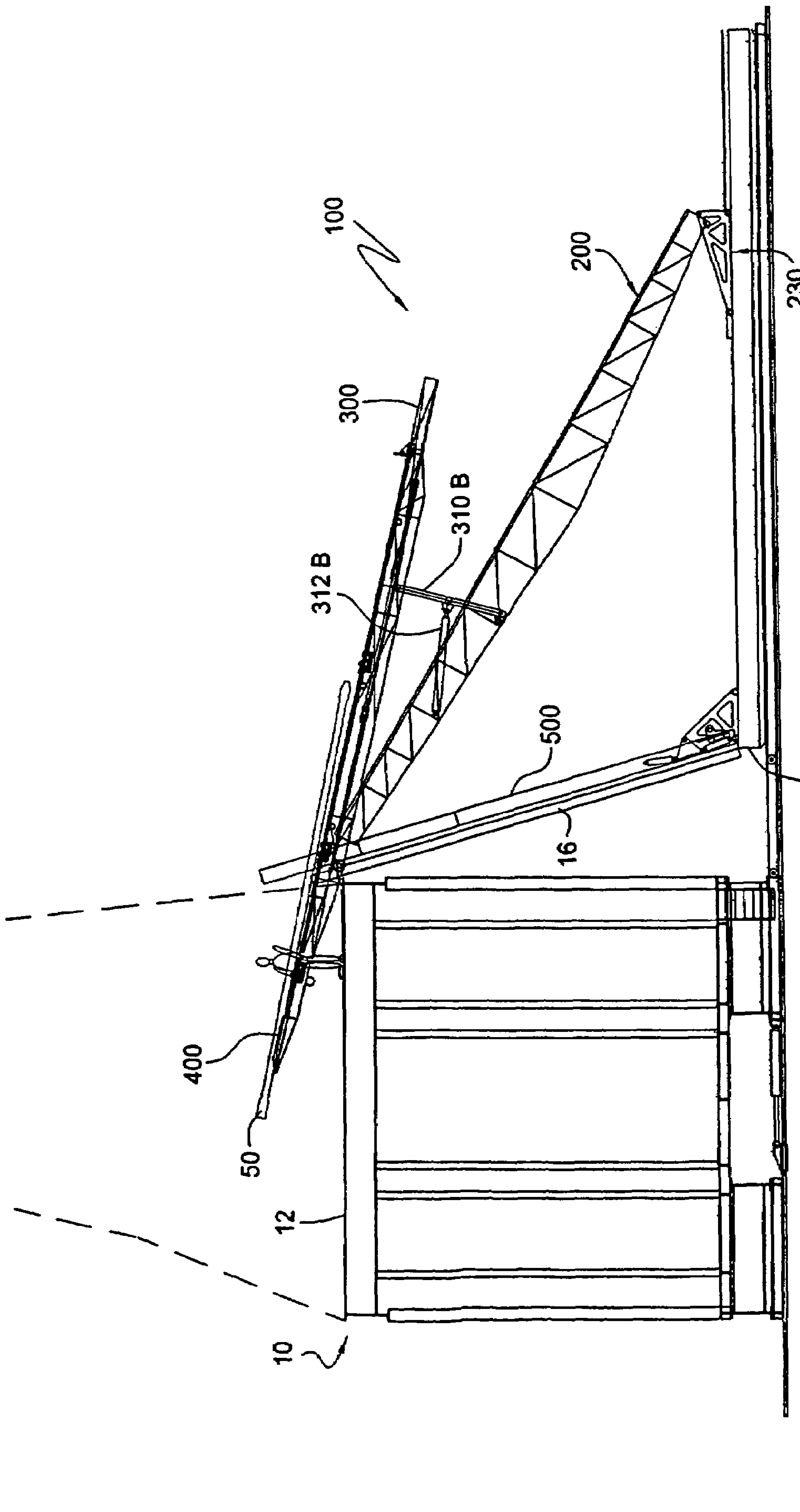
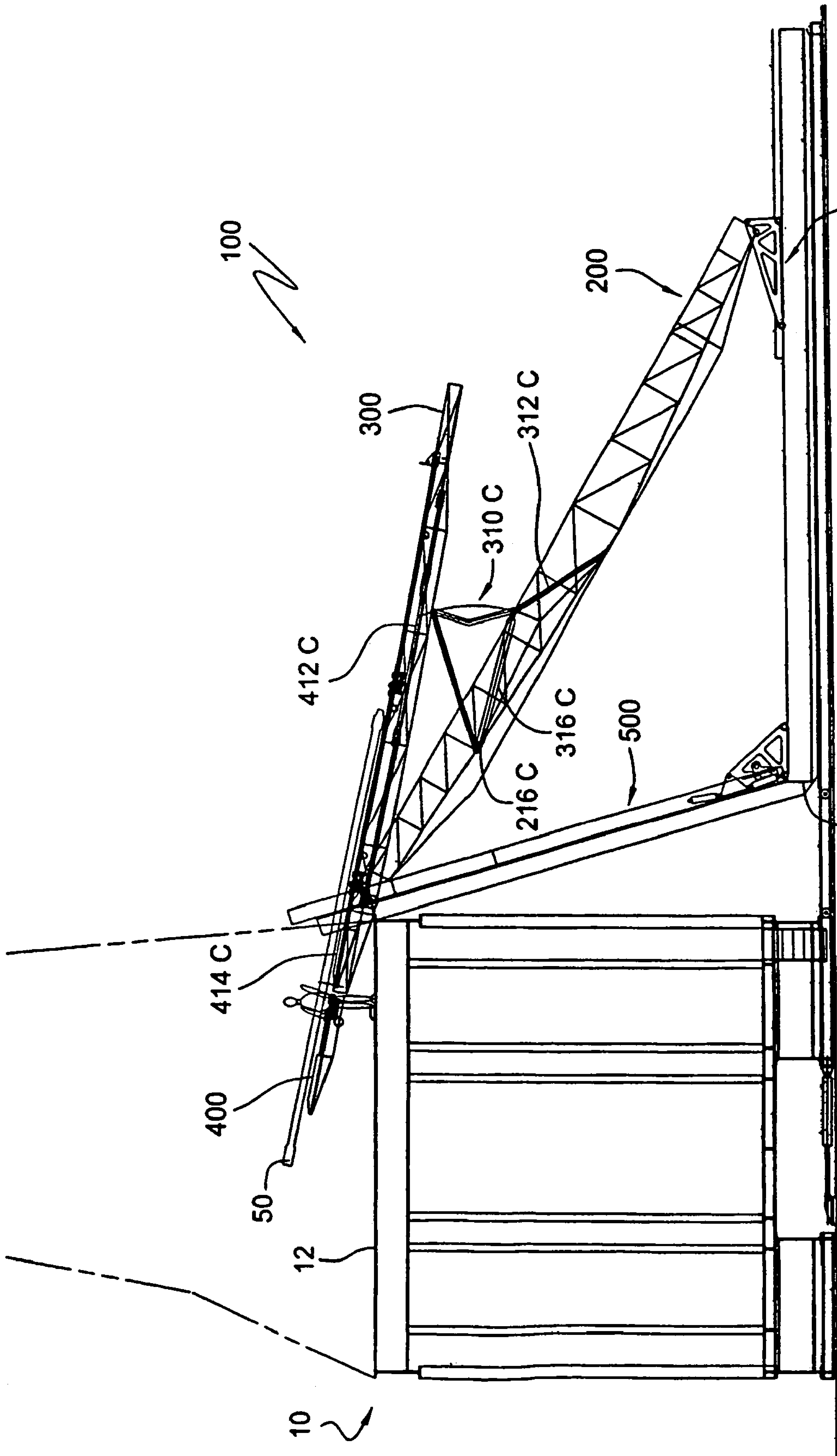
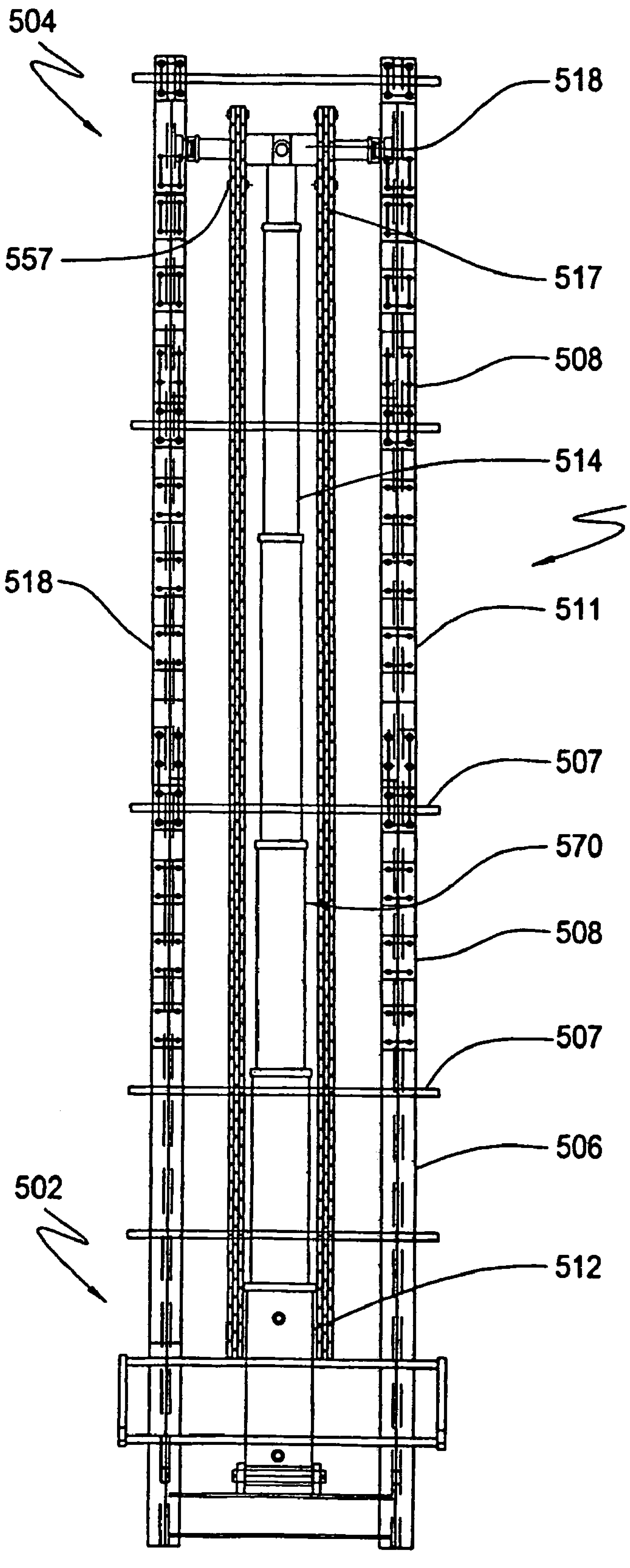


FIG. 5B



100
300
310 C
312 C
200
230
412 C
316 C
500
216 C
190
414 C
400
50
12
10

FIG. 5C


504
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570
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507
506
502
512

FIG. 6A

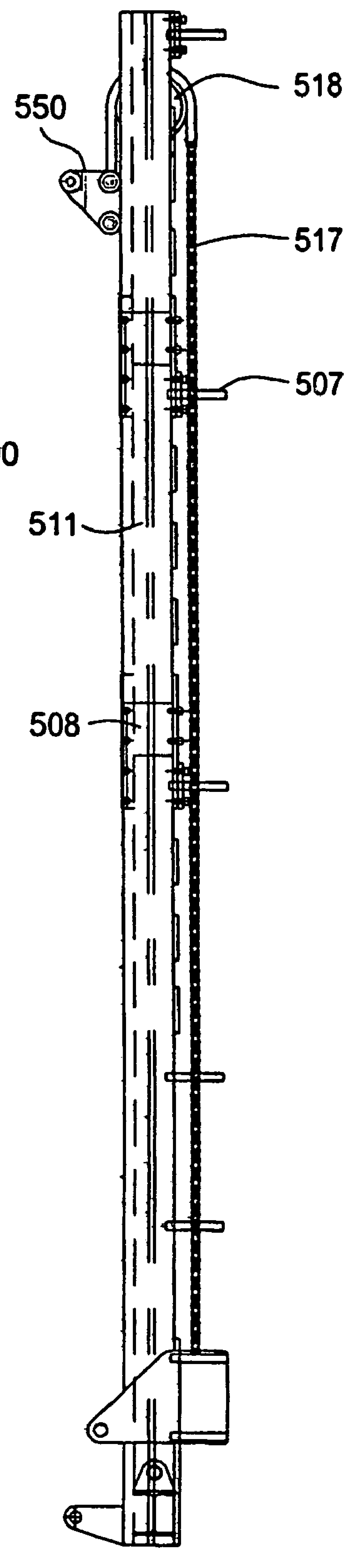
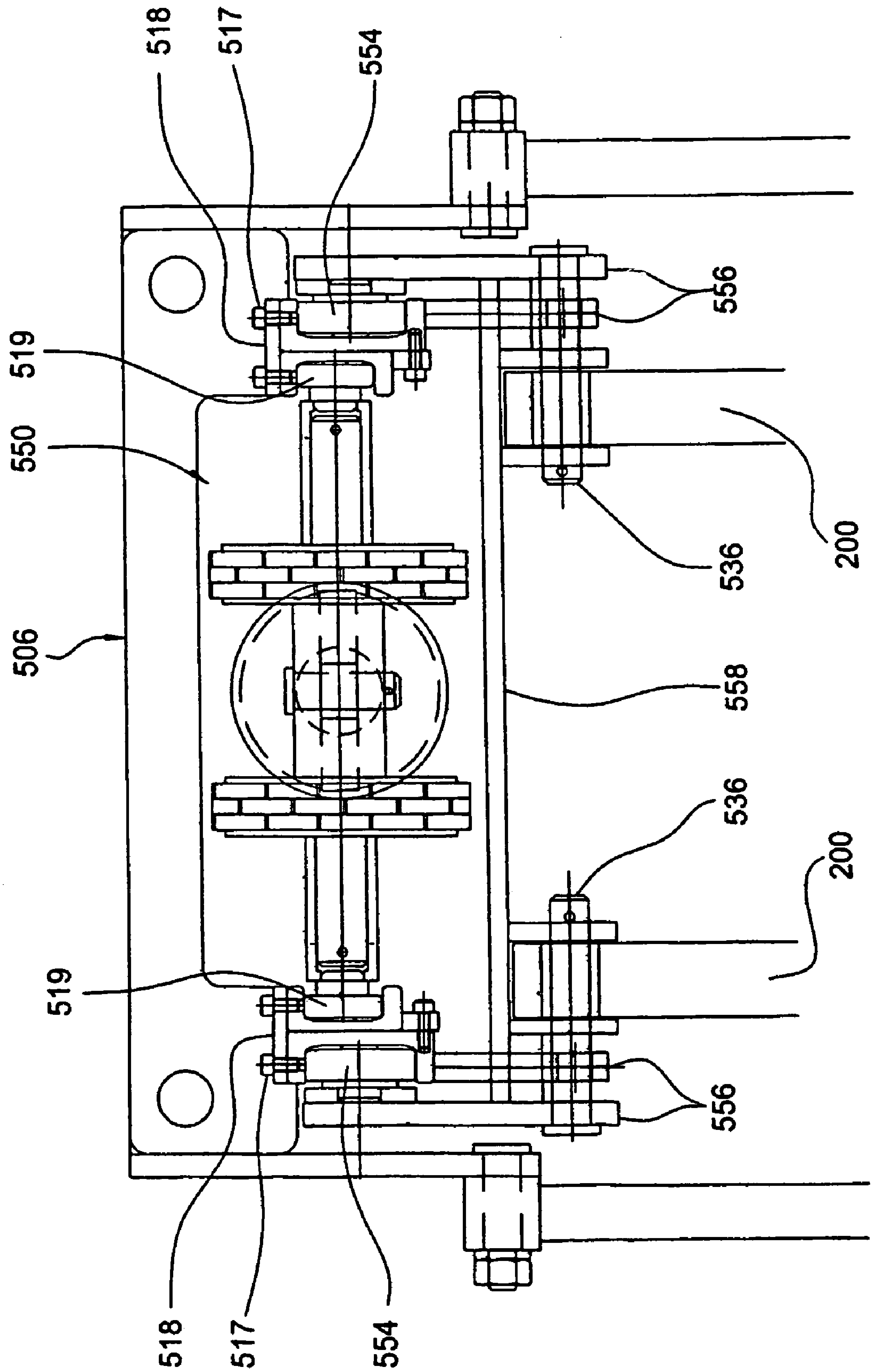

550
518
517
507
511
508

FIG. 6B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556
536
200
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200
556

FIG. 7

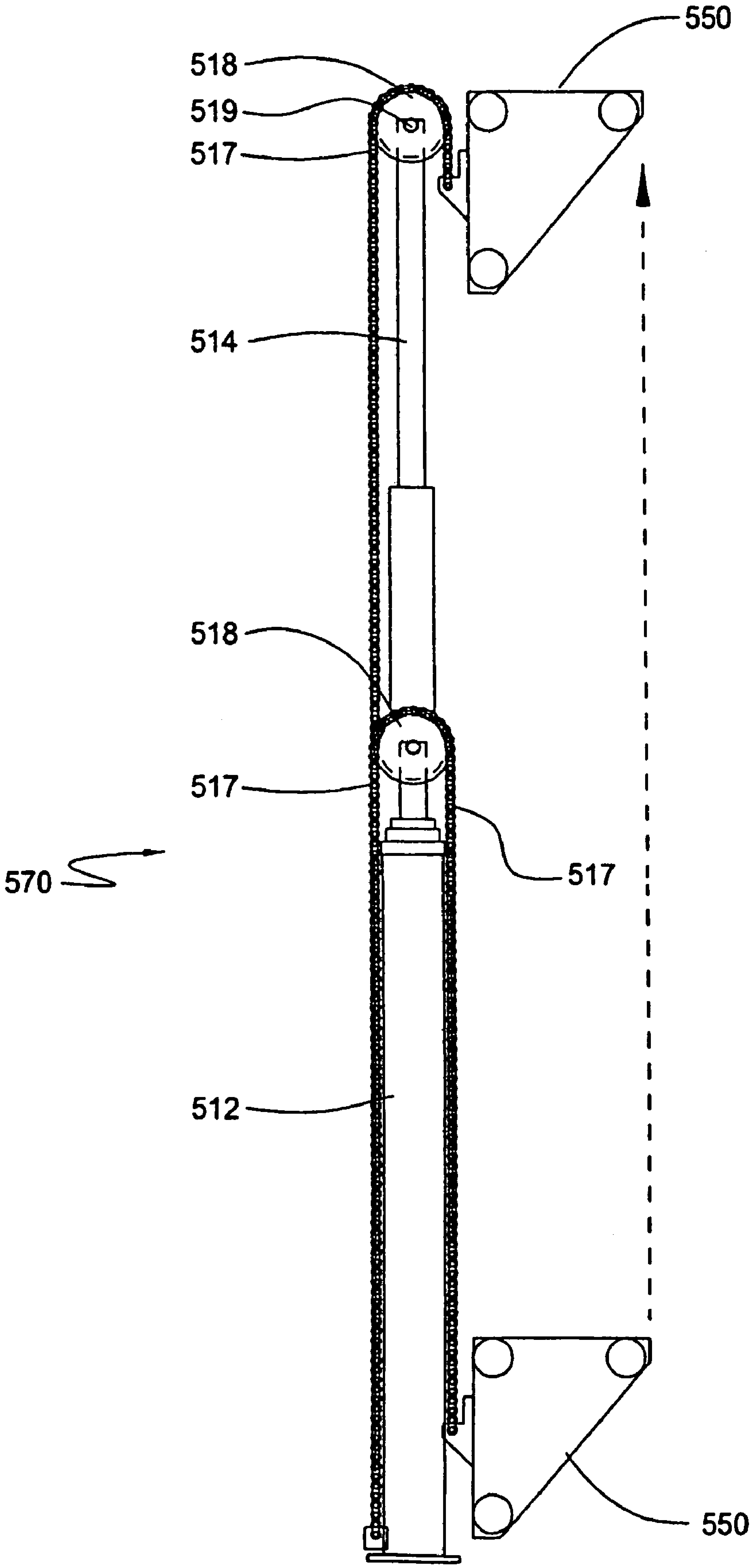

FIG. 8A

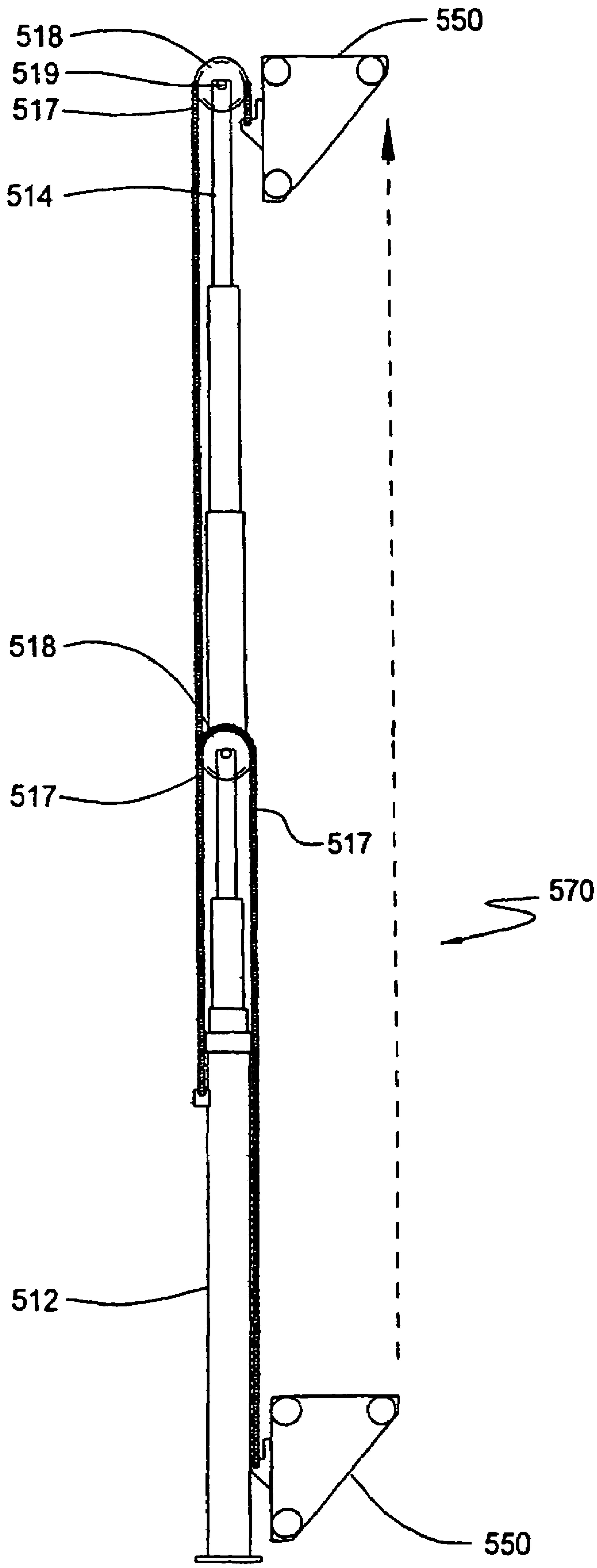

FIG. 8B

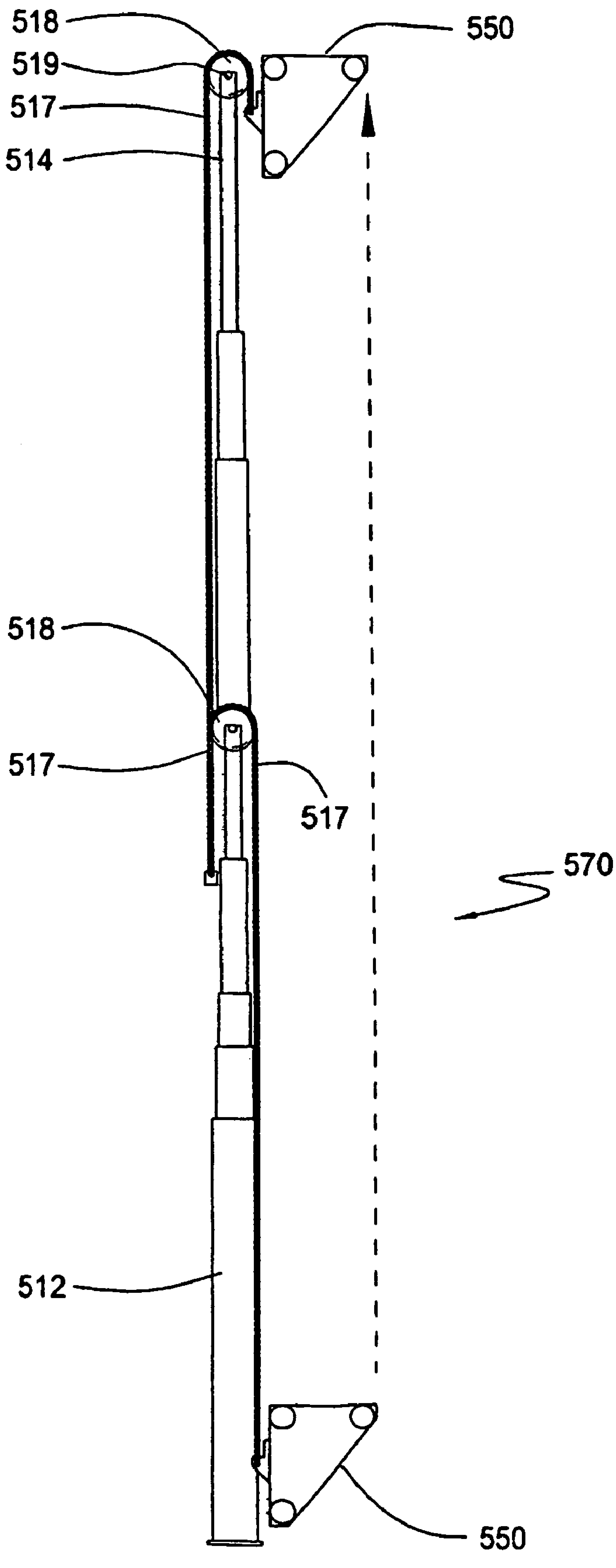

FIG. 8C

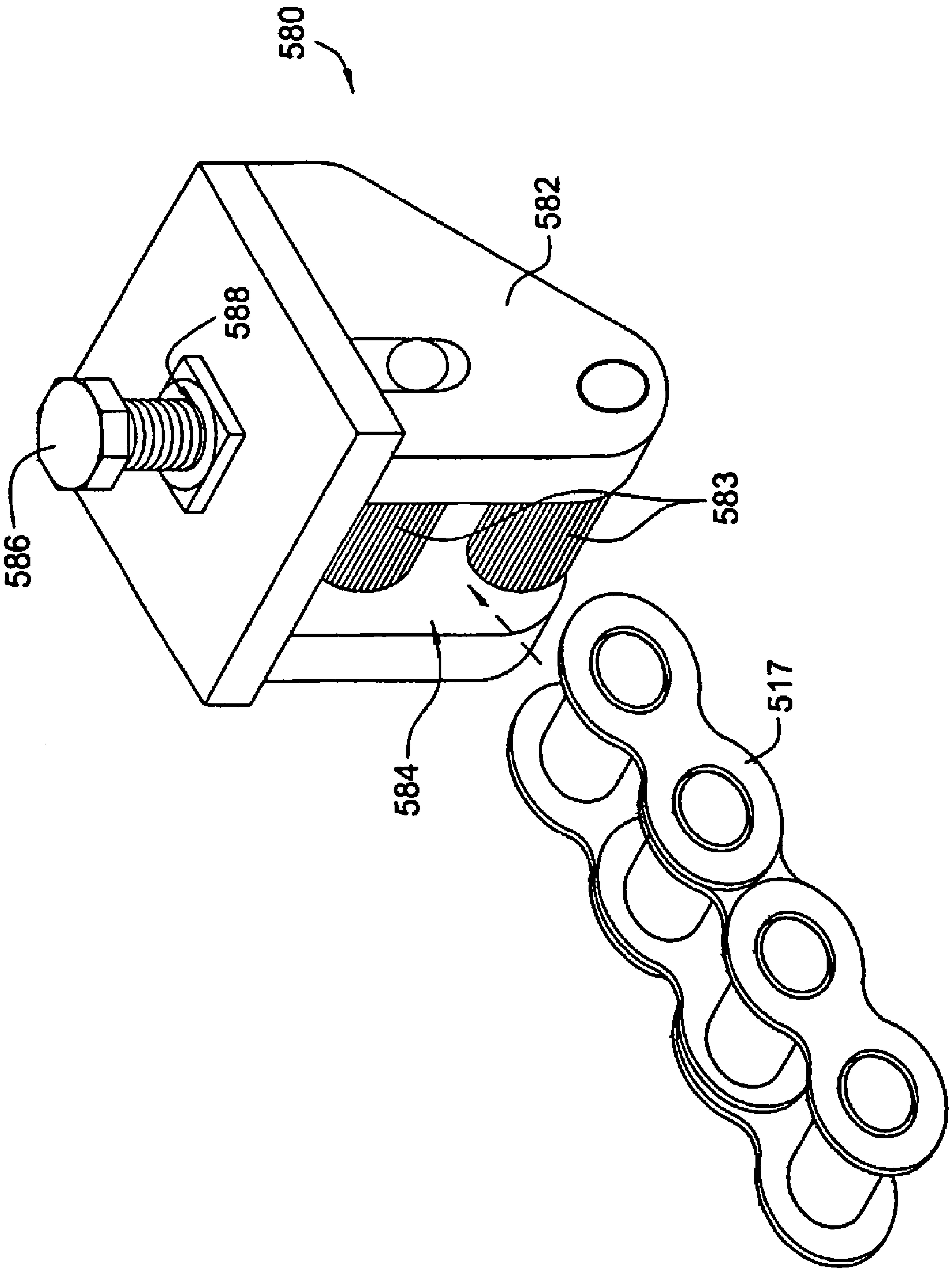

FIG. 9A

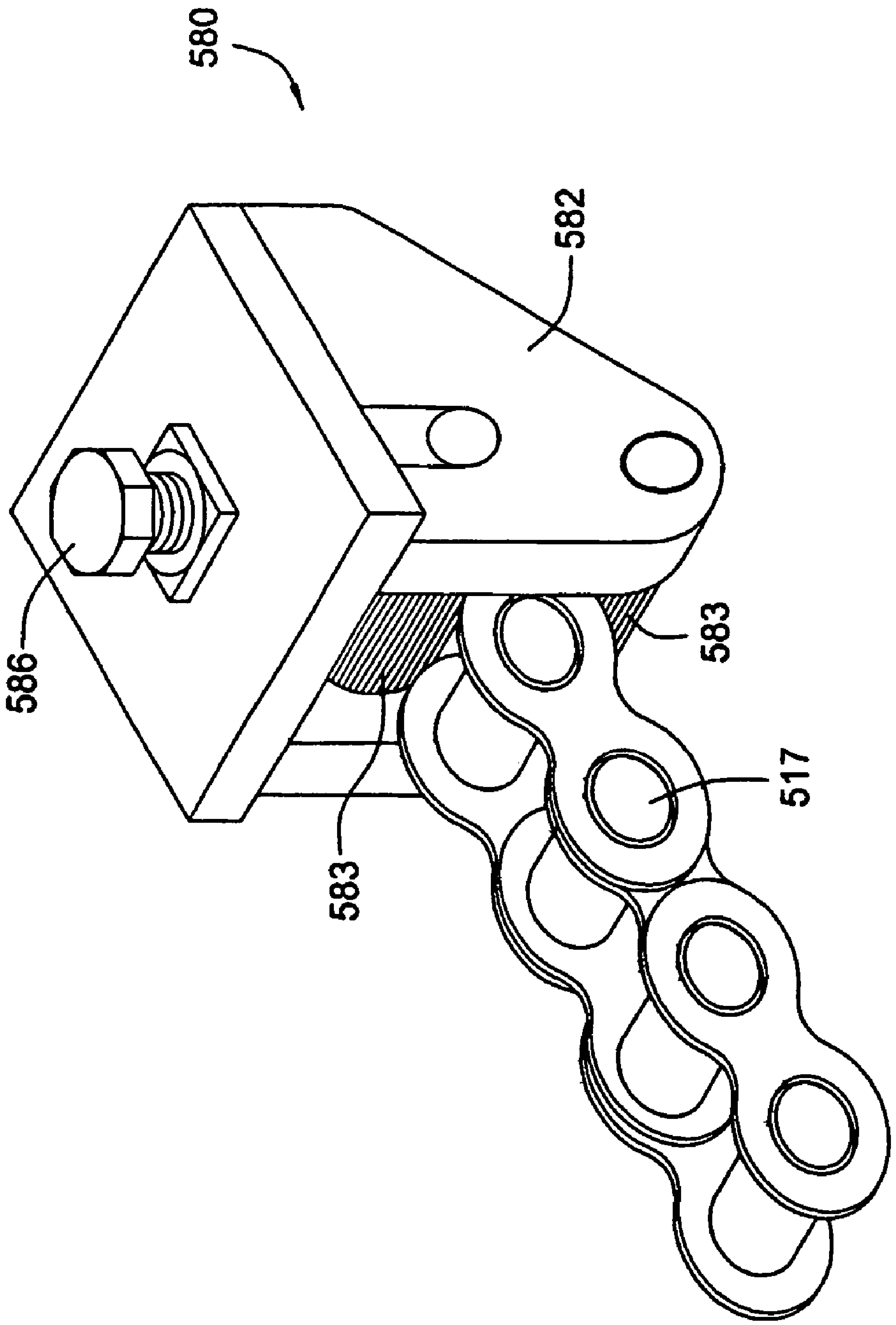

FIG. 9B

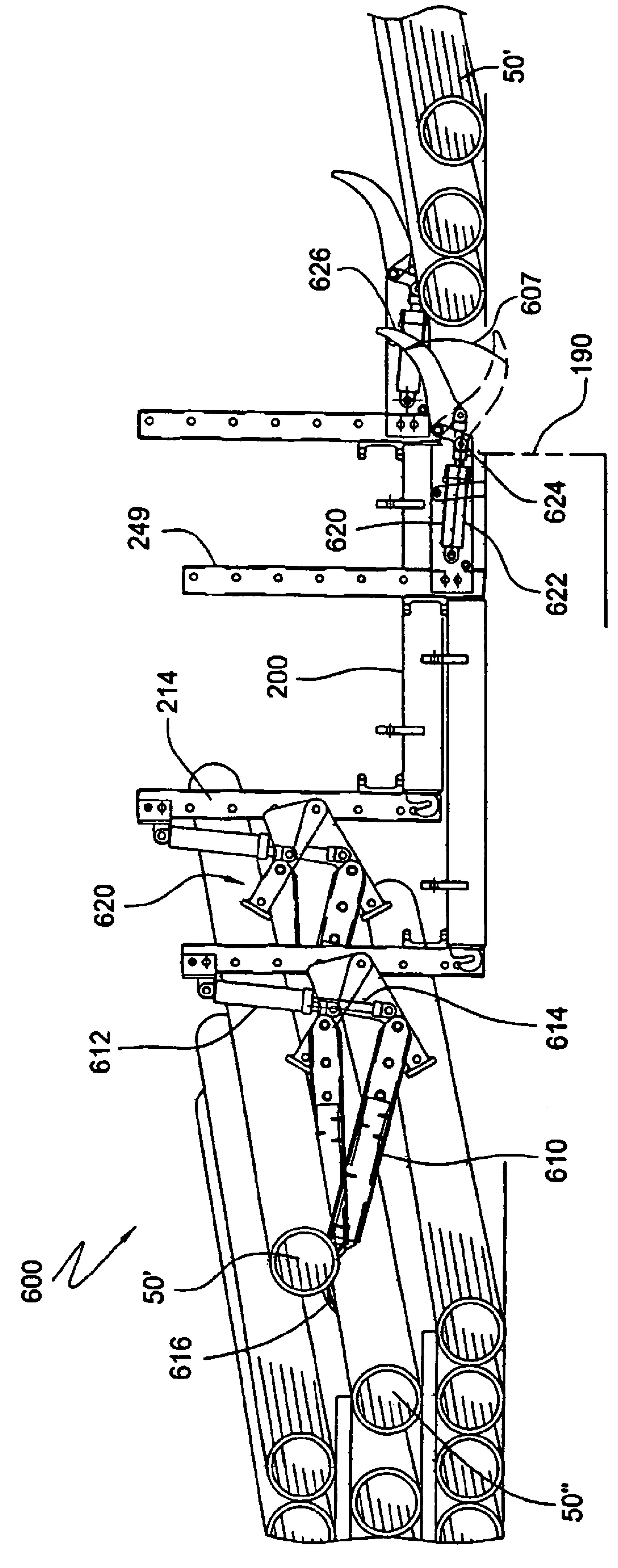
50'
626
607
190
249
620
624
622
200
214
620
612
614
610
600
50'
616
50"

FIG. 10A

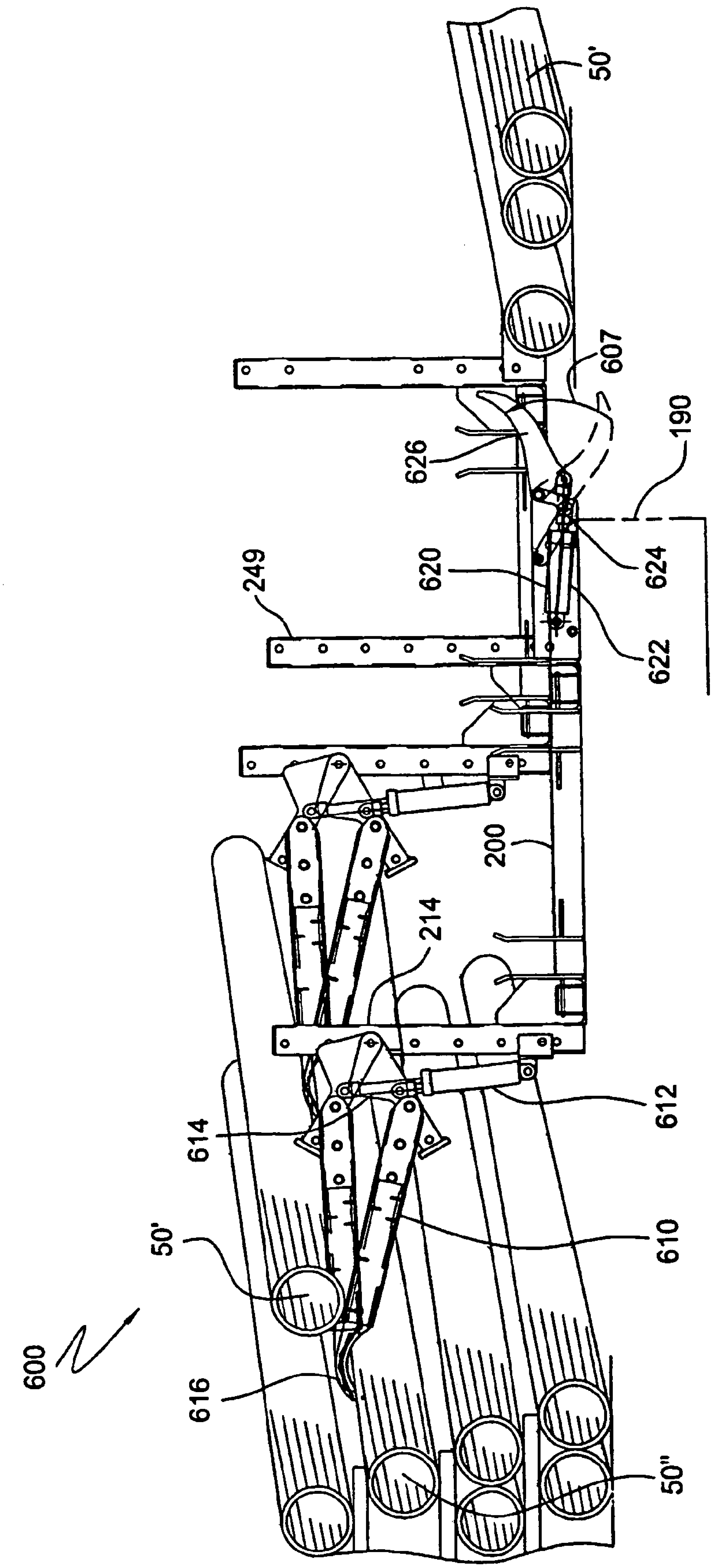

FIG. 10B

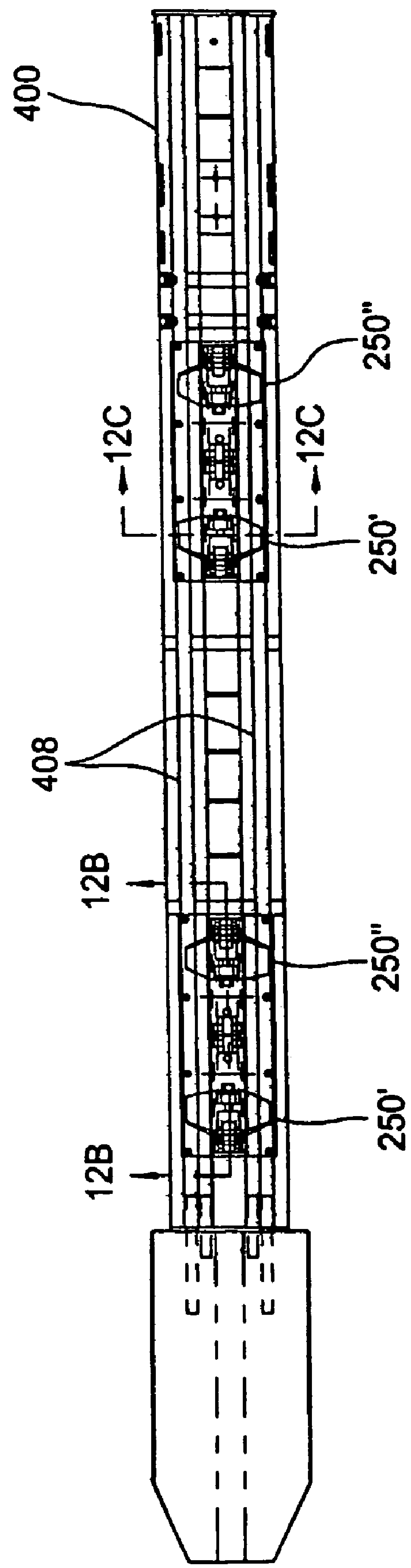

FIG. 11

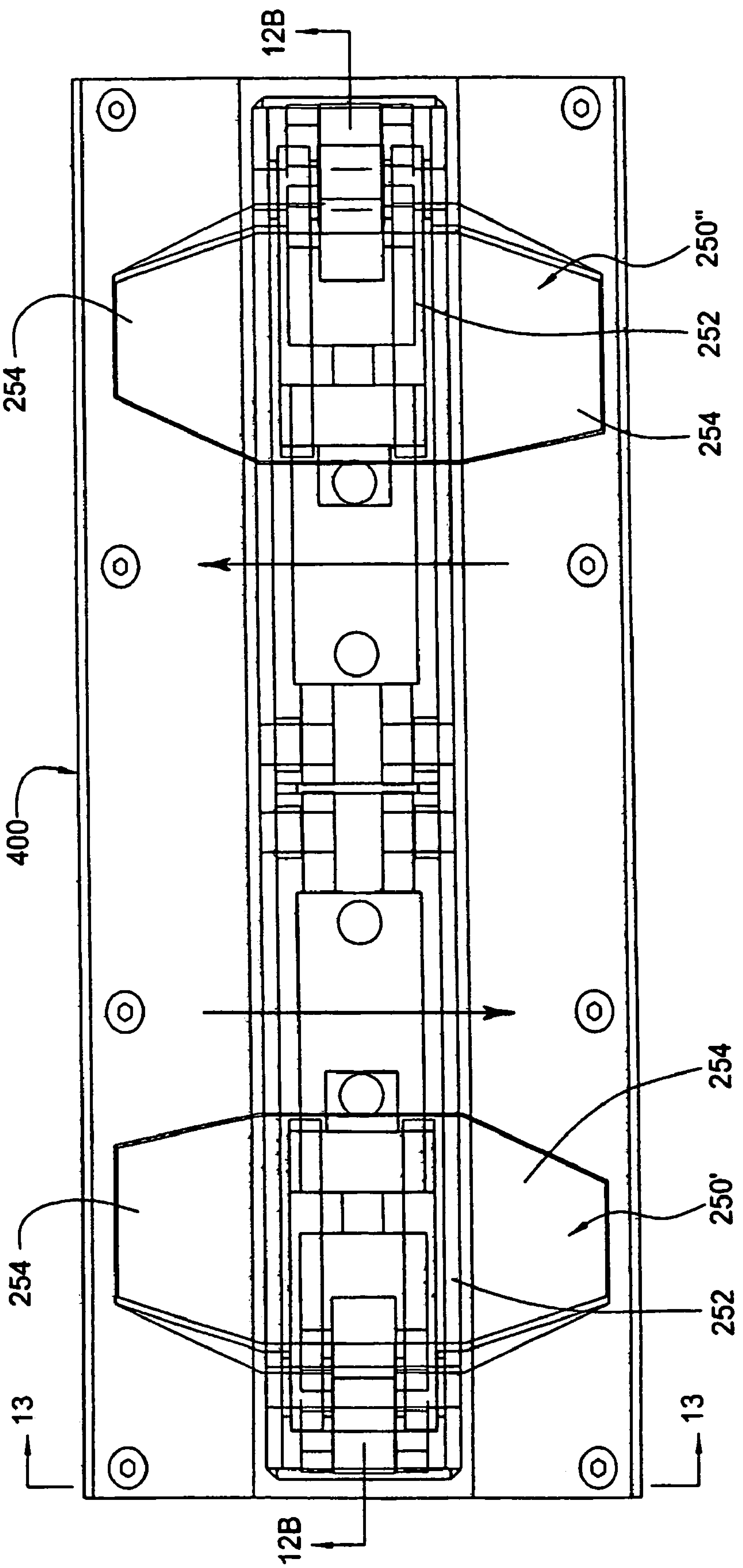

FIG. 12A

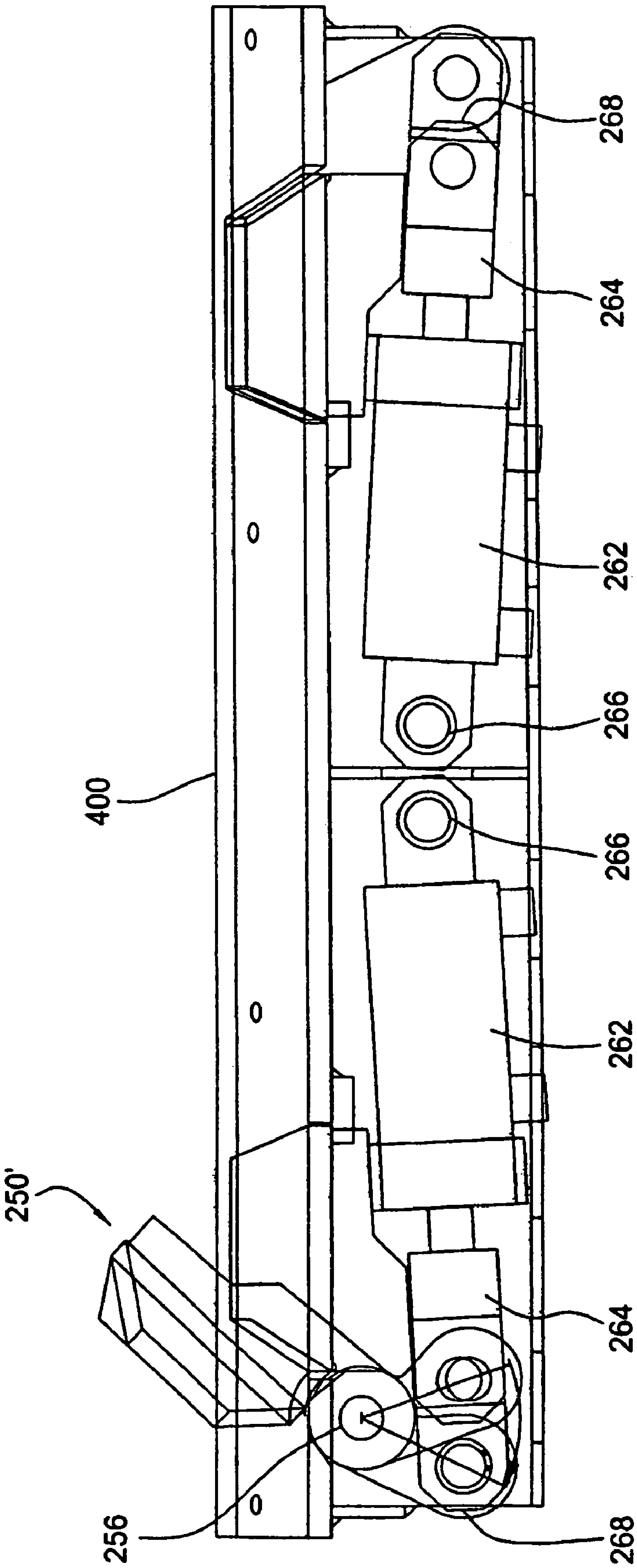

FIG. 12B

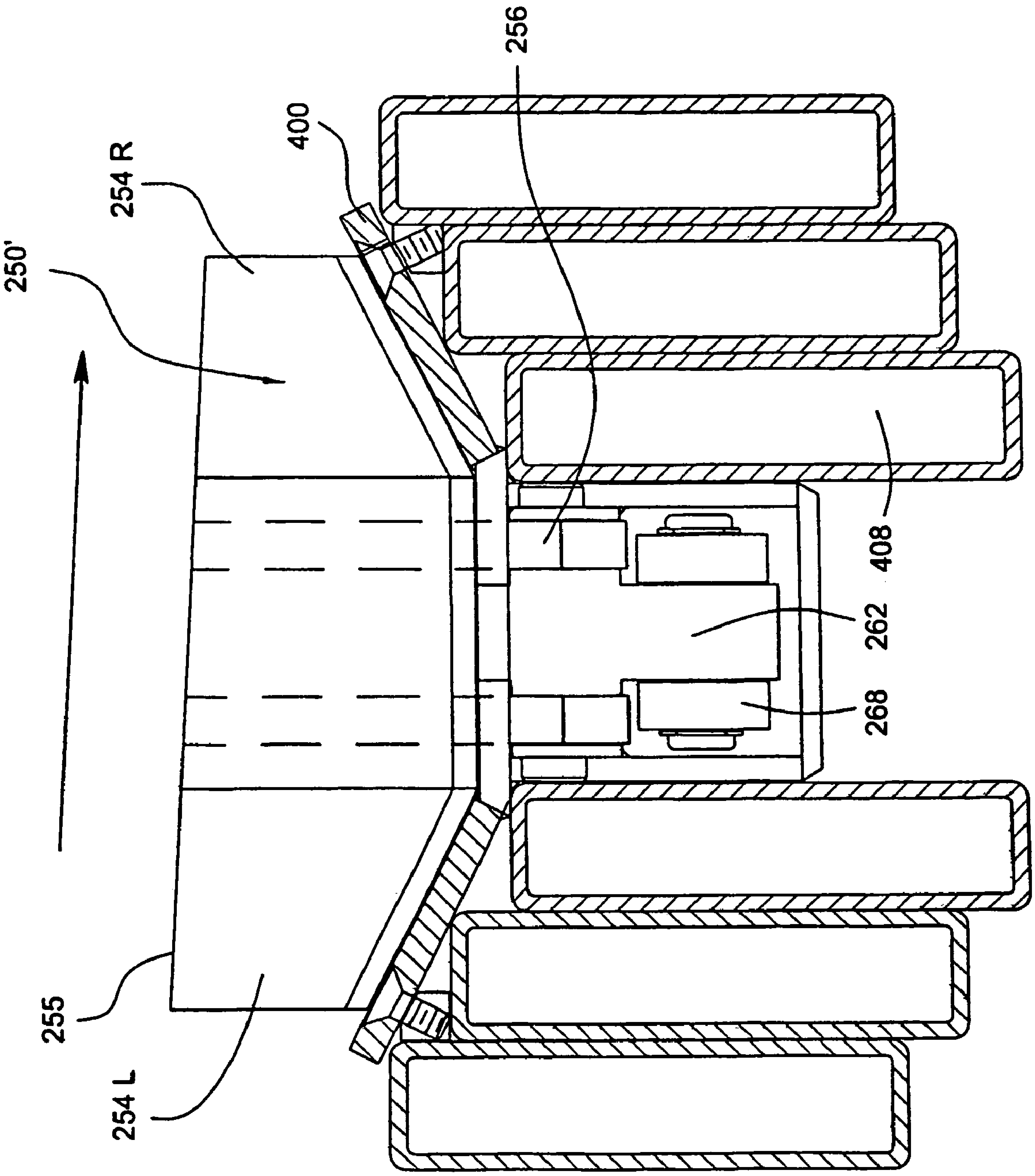

FIG. 12C

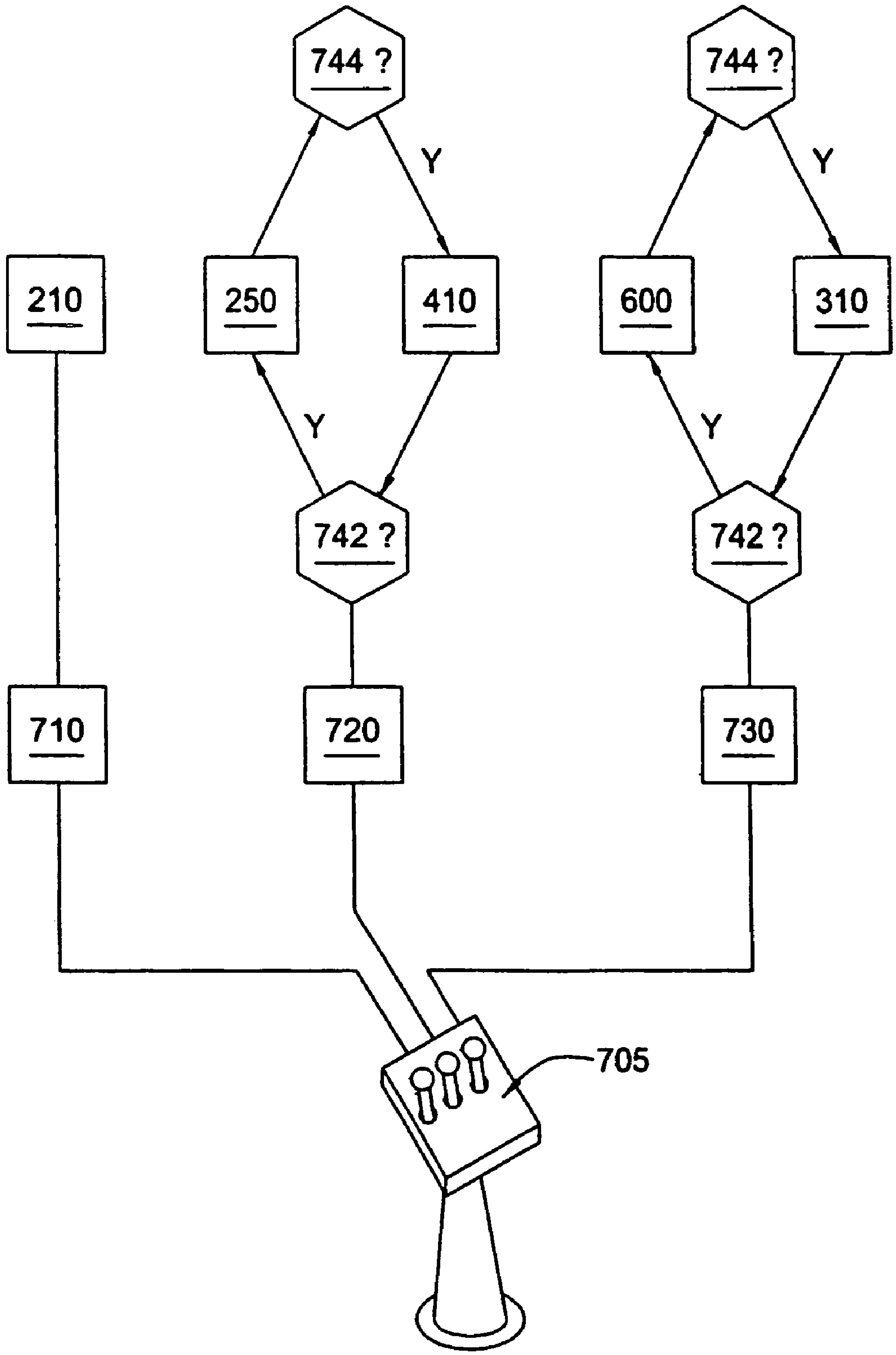

FIG. 13

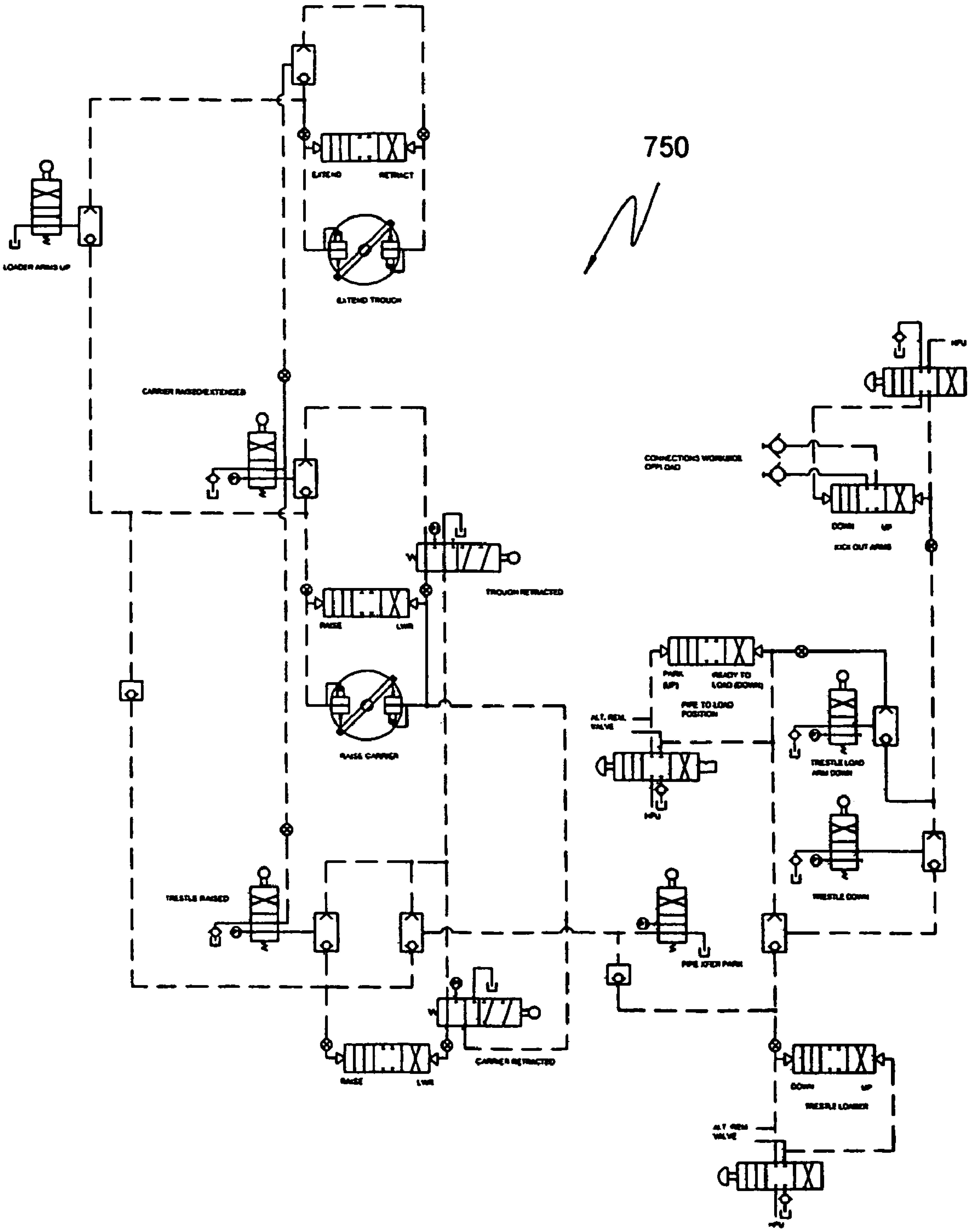
750
EXTEND
RETRACT
EXTEND TROUGH
LOADER ARMS UP
TROUGH RETRACTED
RAISE
LWR
RAISE CARRIER
TRESTLE RAISED
CARRIER RETRACTED
KICK OUT ARMS
DOWN
UP
ALT. REM. VALVE
HPU
TRESTLE DOWN

FIG. 14

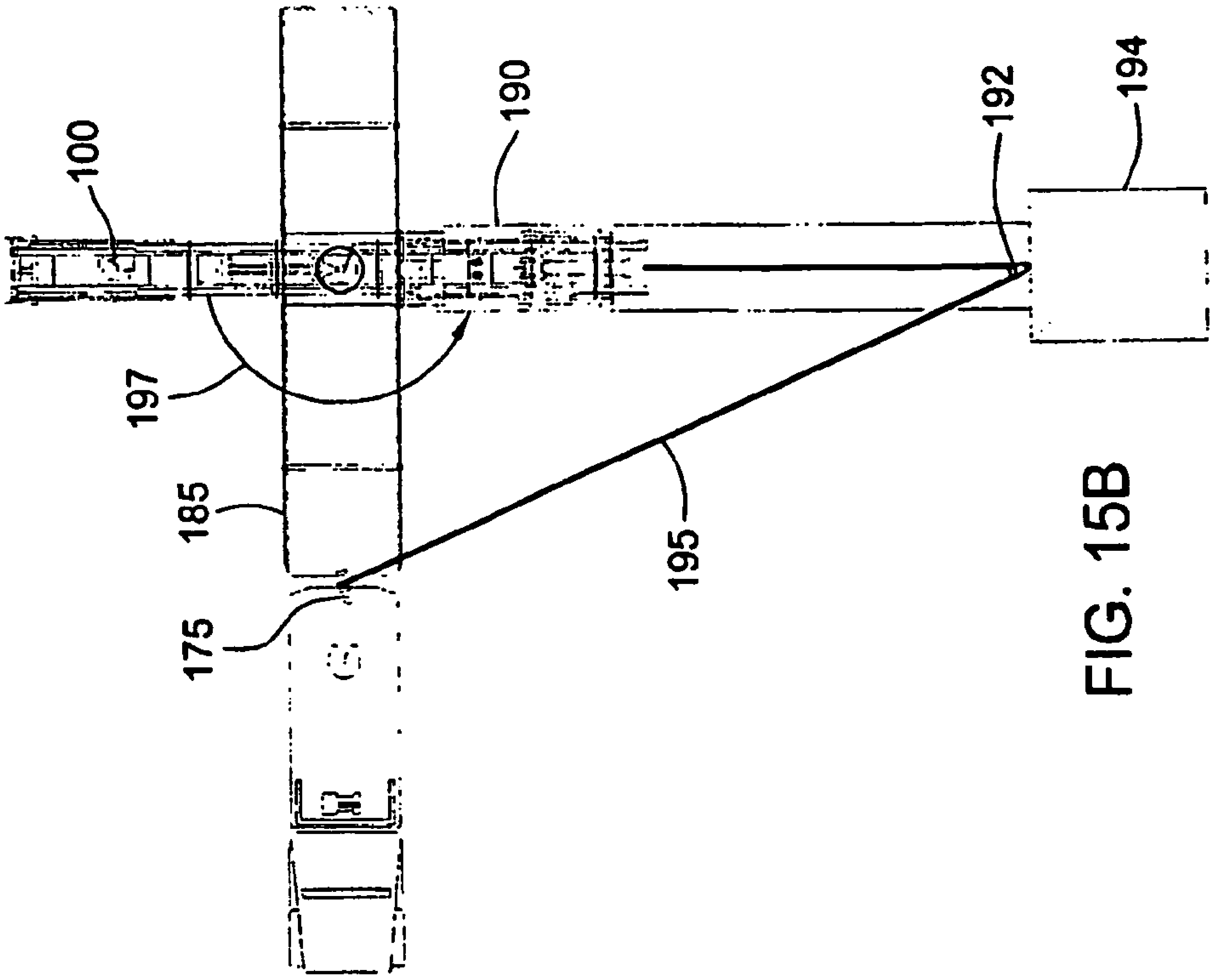

FIG. 15B

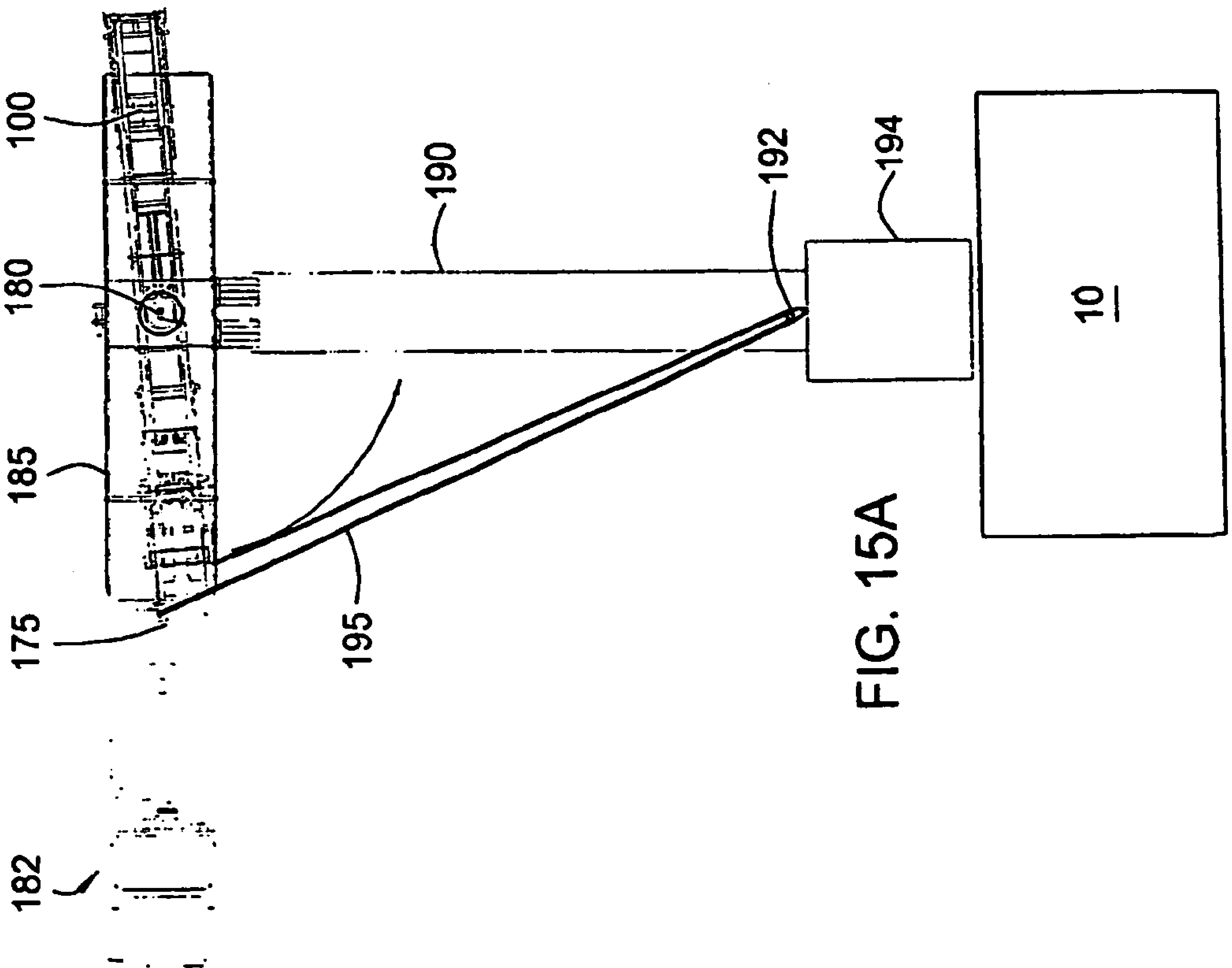

FIG. 15A

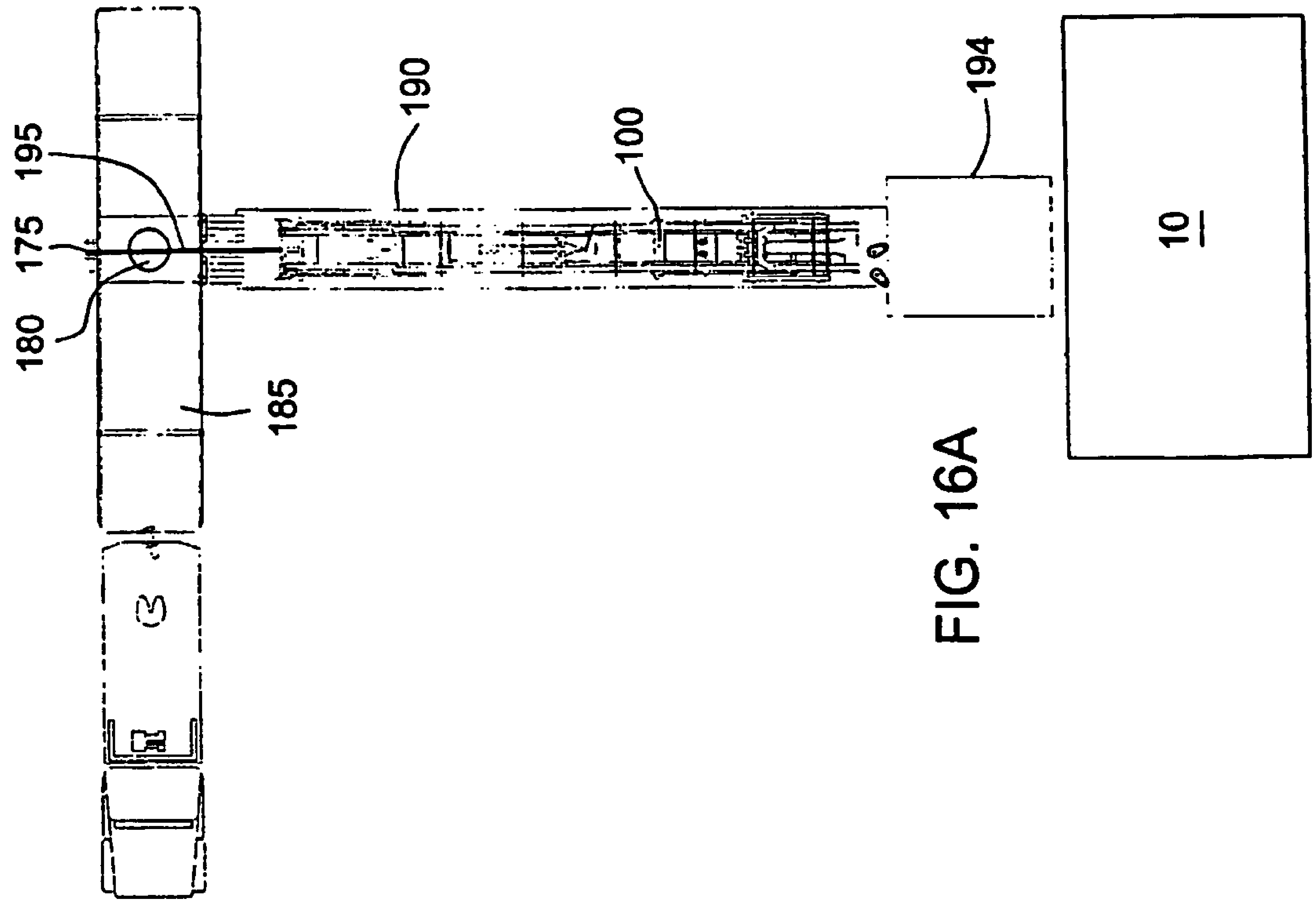

FIG. 16A

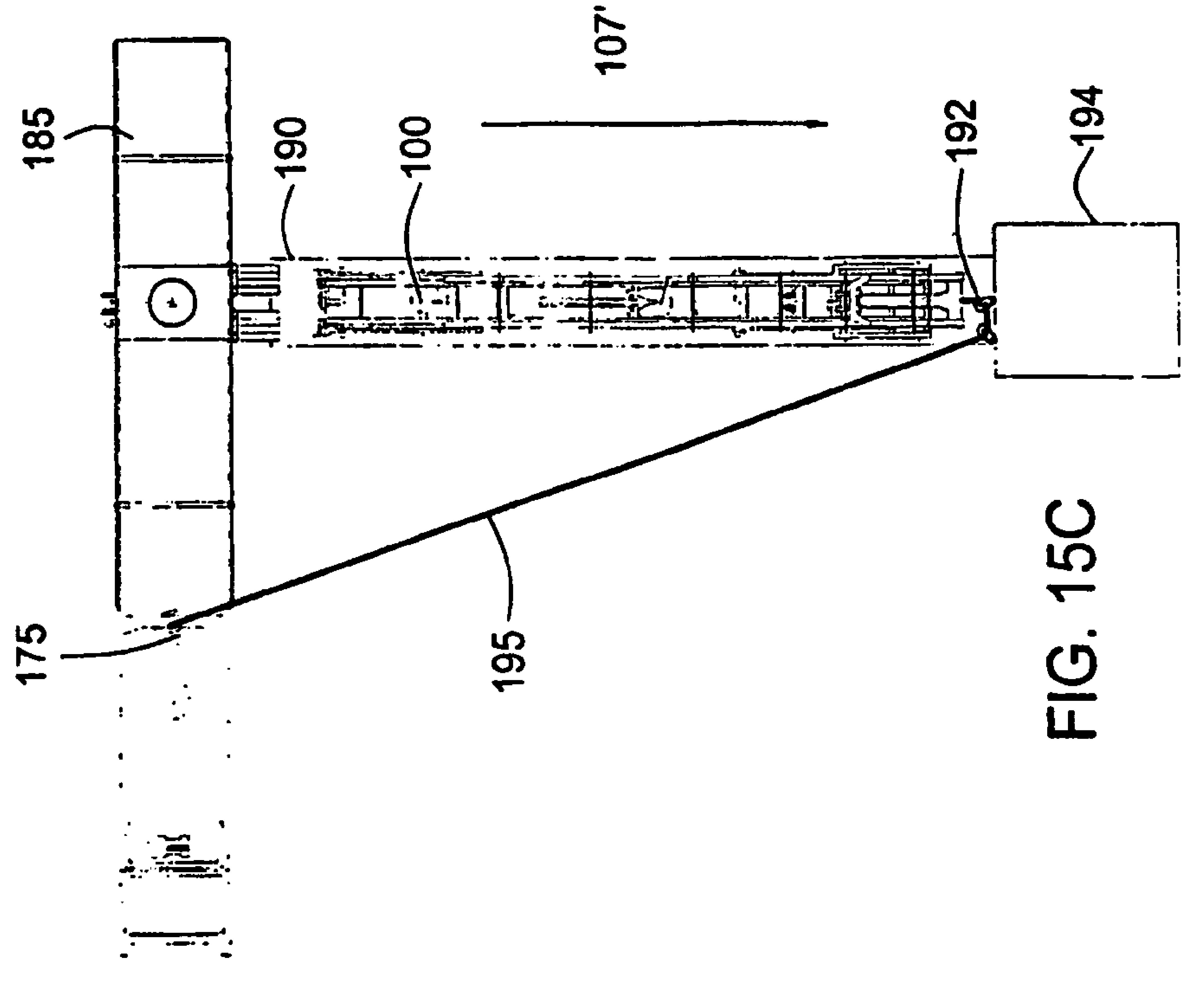

FIG. 15C

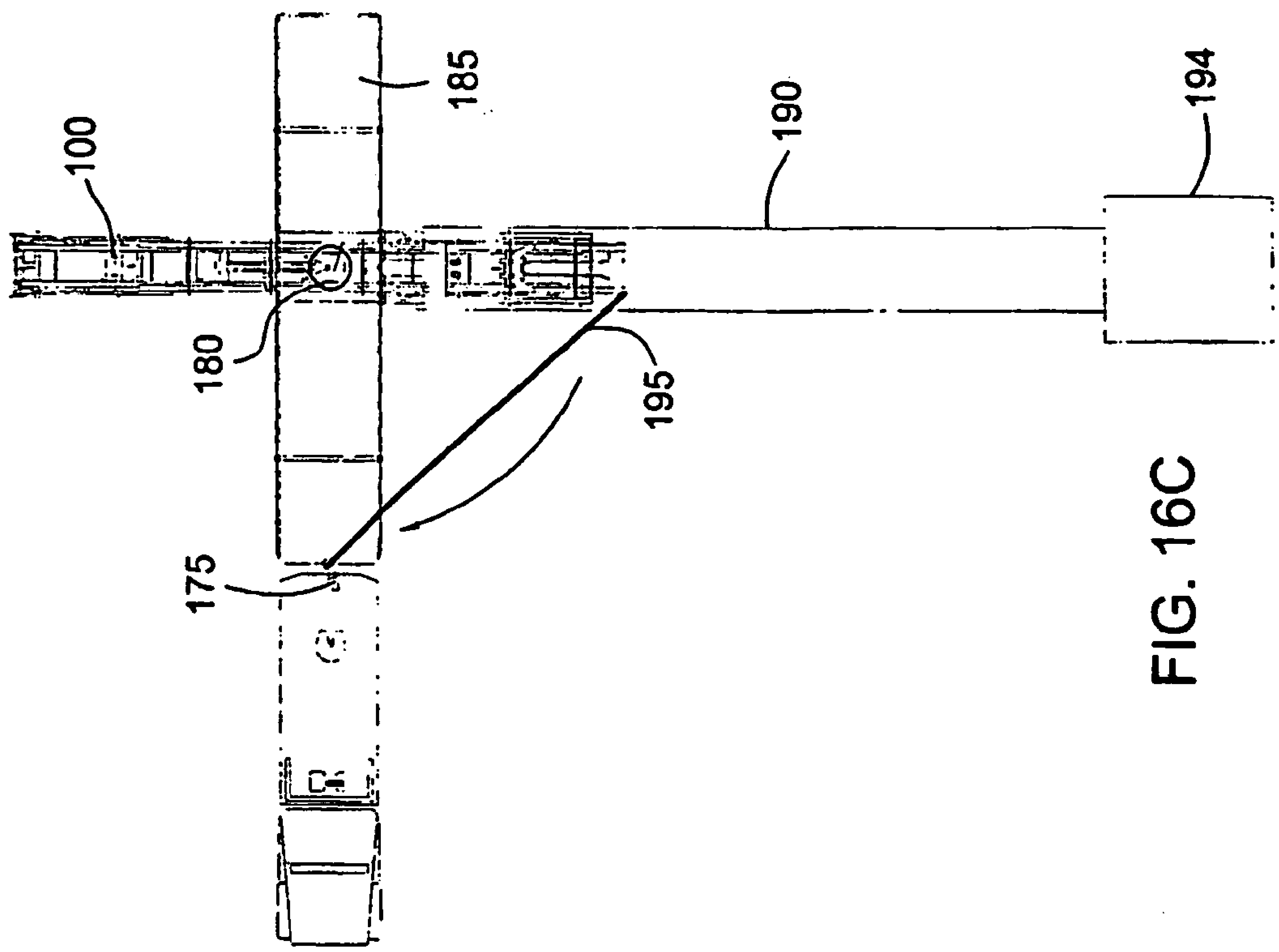

FIG. 16C

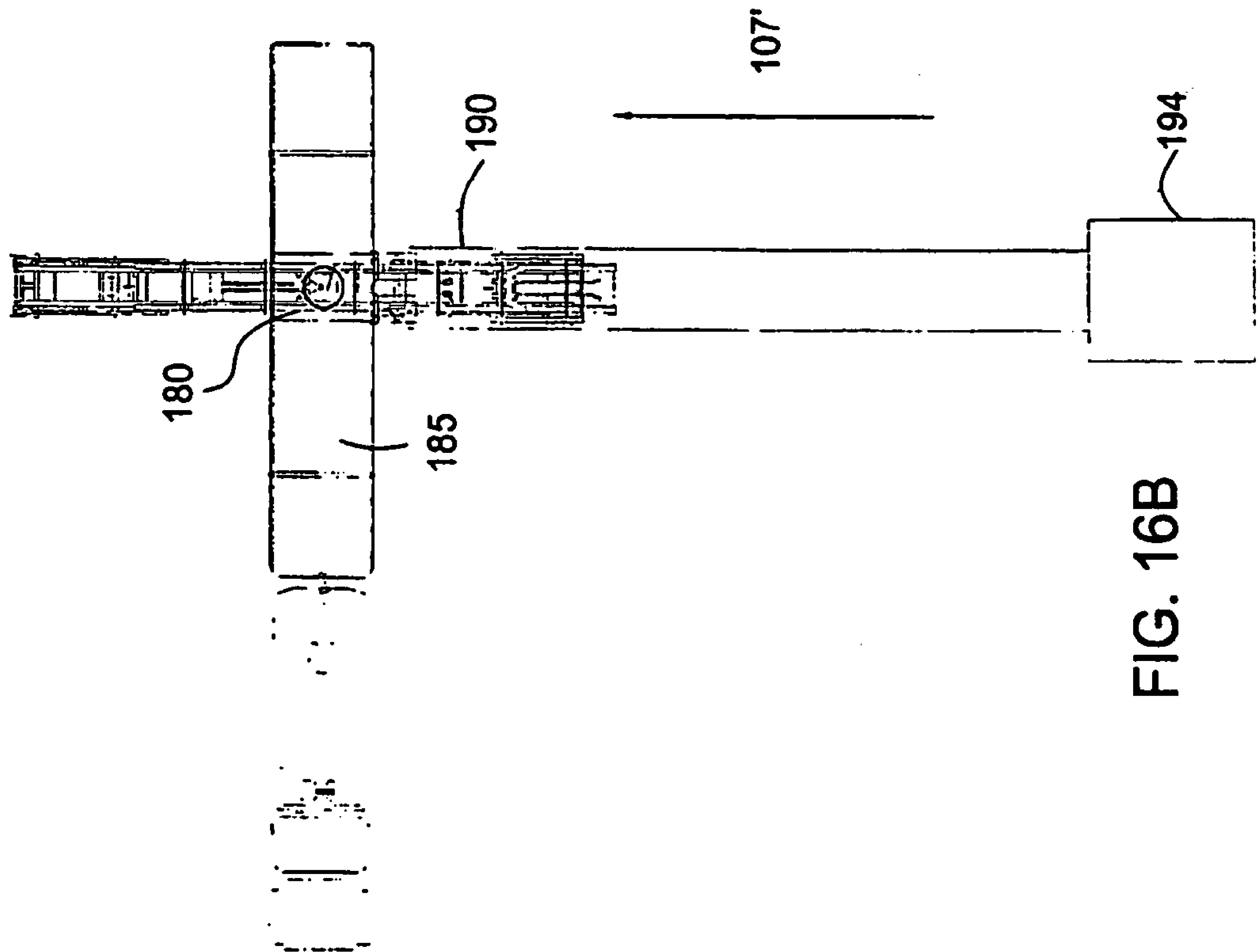

FIG. 16B

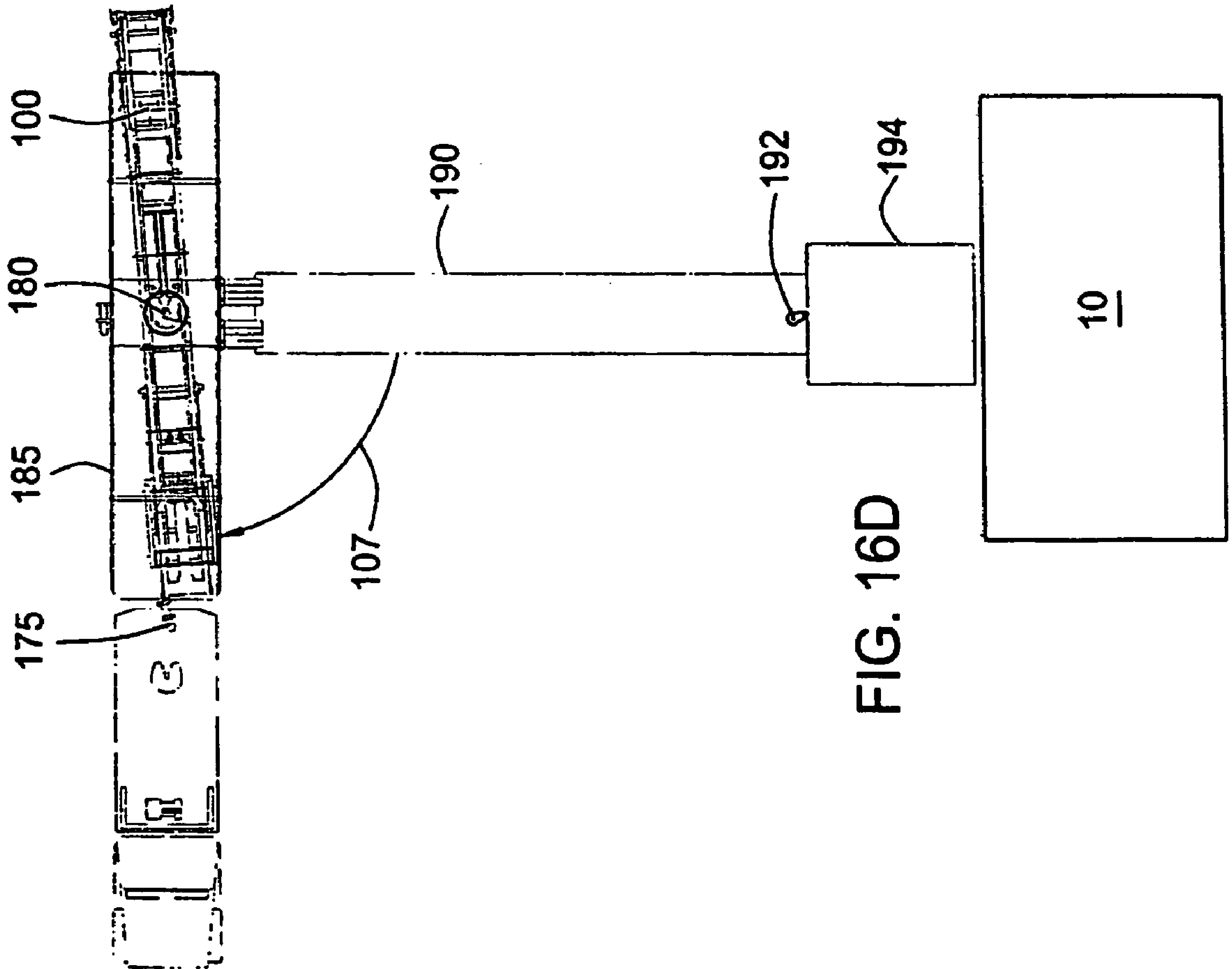

FIG. 16D

HEIGHT-ADJUSTABLE PIPE PICK-UP AND LAYDOWN MACHINE

CROSS-REFERENCE TO RELATED APPLICATIONS

This new application for letters patent claims priority from an earlier-filed United States provisional patent application entitled “Height Adjustable Pipe Pick-Up and Laydown Machine.” That application was filed on May 3, 2002 and was assigned Application No. 60/377,431. The provisional application is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to pipe handling systems for handling a tubular pipe. More particularly, the present invention relates to pipe pick-up and lay-down systems for use in drilling operations.

2. Background of the Related Art

In the drilling of oil and gas wells, it is known to employ various types of tubular pipe. Such pipes include drill pipe, drill collars, production tubing, well casing, and riser pipe. Such pipe is delivered to the drilling rig, and laid in individual joints horizontally upon a pipe rack. In the case of land wells, the pipe is typically delivered by a flat-bed truck. For offshore drilling, the pipe is delivered by barge or on a large floating vessel.

In order to use the pipe on the drilling rig, it is necessary to transport the pipe from the pipe rack to the rig floor. However, picking up and laying down drill pipe, casing and other tubular goods presents certain hazards to personnel on the rig floor. In addition, the manual handling of pipe, even with the assistance of wirelines, creates a risk that the pipe threads may be damaged. These concerns are magnified by the ever-increasing height of rig floors necessitated by the drilling of deeper wells.

Various patents have issued which provide pipe pick-up and laydown systems. These systems typically involve the use of wirelines or cables to transport pipe from a pipe rack or truck bed to the rig floor. Such patents include:

U.S. Pat. No. 4,491,450 issued to George on Jan. 1, 1985;

U.S. Pat. No. 4,054,310 issued to Crocker on Oct. 18, 1977;

U.S. Pat. No. 4,099,630 issued to Beck on Jul. 11, 1978; and

U.S. Pat. No. 4,082,193 issued to Teague on Apr. 4, 1978.

These patents disclose systems that, while commonly used, require manual manipulation of pipes.

Other patents have attempted to reduce the involvement of rig hands in the handling of pipe by providing a trough for lifting pipe from the pipe rack to the rig floor. Such patents include:

U.S. Pat. No. 4,235,566 issued to Beaman, et al. on Nov. 25, 1980;

U.S. Pat. No. 4,054,310 issued to Thompson on Sep. 13, 1983; and

U.S. Pat. No. 4,552,498 issued to Dysarz on Nov. 12, 1985.

However, these systems are not readily adaptable to rigs of varying heights. In this respect, higher rig floors create steeper angles of approach from the catwalk or pipe handling area to the rig floor. If the angle of approach is too steep, the upper end of the joint of pipe will be too high above the rig floor for a worker standing on the floor to safely reach. Therefore, means are required to raise the rear end of the pipe to lower the angle of approach for the upper end of the pipe with respect to the elevated rig floor. It is thus desirable to be able to lift the pipe from the rear portion so as to reduce the angle at which the pipe is fed onto the rig floor.

U.S. Pat. No. 4,486,137 issued to Buckner on Dec. 4, 1984 provides a machine that lifts a pipe trough from the rear; however, a cable is apparently still required for lifting the front end of the trough to the rig floor.

Therefore, it is desirable to provide a pipe pick-up and laydown system that includes a V-Door ramp of adjustable height so as to adapt the pick-up and laydown system to rigs of various heights. Still further, it is desirable to provide a pick-up and laydown system that has improved mobility for quickly delivering the system to the wellsites. Further still, a need exists for a system that enables pipe to be picked up from a pipe rack, placed in a trough, and the trough and pipe moved to a position on the drilling rig floor without the need for a cable or wireline attachment to the pipe.

There is yet a further need for such a system that delivers pipe over the rig floor a greater distance than known systems. In this regard, it is desirable to deliver pipe as close as possible to the wellbore being formed. In this manner, the rear end of the delivered pipe does not swing as much when the pipe is lifted from the pickup and laydown system.

In addition, there is a need for a pipe-handling machine that can be operated solely through hydraulic power. There is further a need for a pipe manipulation system having a greater capability for adjusting the angle at which pipe is presented to the rig floor. Finally, a need exists for a pipe pick-up and laydown system that is essentially remotely operable.

SUMMARY OF THE INVENTION

The present invention provides a novel pipe pick-up and laydown machine. In one arrangement, the machine is remotely operable, and requires minimal manual manipulation of pipe joints by the rig hands. In addition, the machine can be adjusted to accommodate rigs of different floor heights.

The pipe pick-up and laydown machine constitutes a pipe-handling machine for handling pipe at a drilling rig. More specifically, the pipe-handling machine is able to receive a joint of pipe from a pipe rack at ground level, and deliver it to the rig floor for vertical stacking and use in drilling or workover operations. Reciprocally, the pipe-handling machine is able to receive pipe from the rig floor, and return it back to ground level where it can be expelled onto an adjacent pipe rack.

The pipe-handling machine generally comprises three separate frames, and a ramp. The frames are carried upward towards a rig floor together along the connected ramp. The three frames and the ramp may be positioned on the catwalk of a drilling rig adjacent the pipe rack. In one aspect, the ramp may be folded over the three nested frames for ease of transport. Upon delivery to the rig site, the ramp is unfolded and elevated so that it leans against the rig. Preferably, the ramp is then supported by the V-Door ramp.

After the ramp is unfolded into a position leaning against the rig, a pipe is received into the pipe-handling machine. More specifically, the pipe is received onto the three frames. Each of the three frames defines an elongated frame structure having a concave upper surface. The first frame is a trestle; the second frame is a trough carrier; and the third frame is a trough for receiving pipe. The three frames are nested, meaning that the trough is received within the trough carrier, while the trough carrier is received within the trestle. To accomplish this nesting arrangement, the upper surface of the trestle is configured to receive the trough carrier, while the upper concave surface of the trough carrier is configured to receive the trough. Finally, the upper surface of the trough is configured to receive a joint of pipe.

A front end of the trestle is pivotally connected to the ramp. As the front end of the trestle is pulled upwards towards the rig floor, the trough carrier and the trough are carried with it. The back end of the trough is pulled along the catwalk as the front end moves forward and upward. In one aspect, the back end of the trestle rides within a base frame that provides lateral support. In one aspect, the rear portion of the trestle defines an articulating leg that may be folded over, thereby reducing the overall length of the trestle during transport. This, in turn, allows the machine to be transported on land via flatbed truck without a DOT permit.

The articulating leg first moves forward within the base frame as the front end of the trestle is elevated along the inclined ramp. The articulating leg engages a stop member in the base frame, causing the rear portion of the trestle to pivot and to be raised off the ground. This serves to reduce the angle of approach for tubulars as they are delivered to the rig floor. The operation is reversed when laying down pipe.

As noted, the trestle receives the trough carrier. In one embodiment, the trough carrier is connected to the trestle by a trough carrier transport mechanism. In one aspect, the trough carrier transport mechanism defines a hydraulic cylinder connected at the rear of the trough carrier, and having an extendable, telescoping arm. Depending upon the configuration of the transport mechanism, the trough carrier may be moved longitudinally along the trestle, may be lifted upward relative to the trestle, or both. The trough carrier transport mechanism is actuated once the front end of the trestle has been raised to the rig floor.

The trough carrier, in turn, receives an elongated trough. The trough has a concave upper surface for receiving pipe from the adjoining pipe rack. In this manner, the trough serves as a cradle for pipe during a pick-up or laydown operation. The trough is slidably mounted within the trough carrier by a trough transport mechanism. The trough transport mechanism, in one arrangement, comprises a hydraulically actuated arm for telescopically extending the trough out of the forward end of the trestle and towards the drilling rig. The trough transport mechanism is actuated once the forward end of the trough has reached the rig floor.

Returning to the ramp, the ramp has a frame structure, and an extendable arm that travels upward within the frame. Preferably, extension is accomplished by a hydraulic arm having telescoping sections. The inclined ramp may be assembled in modules, allowing additional sections to be incorporated for higher rig floor heights. In one arrangement, modules permit the ramp to be dimensioned between 16 and 35 feet in total length.

A carriage is provided on the inclined ramp. The carriage rides along a channel provided in the frame. At the same time, the carriage is pivotally connected to the trestle. Thus, a lifting of the carriage along the channel carries the front end of the trough to the rig floor. In one aspect, the carriage is lifted via chains that are pulled over a sheave at the distal end of the hydraulic arm within the ramp. The result is that for each foot the hydraulic arm is raised, the carriage travels two feet. The hydraulic cylinder, sheave, chains, channel and carriage together form one arrangement for a trestle transport mechanism.

An optional pair of hands is provided on one or both sides of the trestle. The hands are placed at the end of vertically or rotationally moveable lifting arms. During a pick-up operation, pipe is rolled from a pipe rack onto the hands. The hands are then raised above the height of the trough and tilted inward so that the pipe gravitationally rolls into the trough.

Another optional feature of the pipe-handling machine provides a means for ejecting pipe from the trough and onto the hands in order to return pipe to the pipe rack, such as during a laydown operation. In one arrangement, the pipe ejection structure comprises a pair of plates having angled wings. The plates are raised via hydraulic arms, causing the pipe to be lifted from the trough. The wings are angled such that a lifting of the pipe also causes the pipe to roll to one side of the trestle, whereupon the pipe joint is received by the hands. The pipe joint is then rolled onto or otherwise delivered to the adjoining pipe rack.

A unique hydraulic circuitry for the machine is also provided herein. In one embodiment, the circuitry includes a position valve that is mechanically actuated when the trestle is on the catwalk. When the trestle is in its lower position on the catwalk, hydraulic circuitry allows operation of the pipe loading and pipe transfer mechanisms, i.e., the lifting hands and the ejection plates. Hydraulic power is removed from the translation apparatuses that move the trough carrier relative to the trestle, and the trough relative to the trough carrier. However, when the trestle is raised by actuation of the hydraulic cylinder within the ramp frame, the circuitry functions are reversed. Thus, when a section of pipe is being raised to the rig floor, the pipe loading and pipe transfer systems cannot be employed, ensuring that pipe will not be ejected from the trough. A second position valve is provided at the top of the ramp. When the upper position valve is reached, the trough carrier/trough transport mechanisms are powered. Preferably, the telescoping ramp cylinders for the trestle transport mechanism are disengaged until the trough and trough carrier are retracted.

As noted, the machine of the present invention is highly mobile. The machine is configured so that the trough and trough carrier may be nested within the trestle. A rear portion of the trestle is foldable over the trestle body. Further, the ramp frame may be folded over the trestle. Using a winch line, the trestle and accompanying machine components may be slidably transferred from a flat-bed trailer to the catwalk, and vice versa. The trestle and attached machine components are rotated into position for use or for transport. Accompanying power sources, such as diesel engines, hydraulic fluid, e.g., oil and canisters may also be carried on the trailer via a skid.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the above recited features of the present invention are attained and can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to the drawings that follow. FIGS. **1** through **16**D are provided. It is to be noted, however, that the attached Figures illustrate only certain embodiments of this invention, and are not to be considered limiting of its scope.

FIG. **1** is a perspective view of a pipe-handling machine constructed in accordance with this invention, in one embodiment. In this view, the pipe-handling machine has been moved to a rig site, and a trestle of the machine is positioned on a catwalk. A portion of a drilling rig is shown. The trestle is in its lower position, but the inclined mast, or "ramp," is raised to position against a drilling rig. The pipe-handling machine is shown somewhat schematically in this view to demonstrate contextual use for the machine.

FIG. **2** is an enlarged side view of the pipe-handling machine of FIG. **1**. The ramp has been unfolded into position against the drilling rig. The trestle is again in its lower position, ready to be carried up the inclined ramp.

FIG. 2A is a side view of a trestle from the pipe-handling machine of FIG. 2. A trough carrier frame and trough frame are shown exploded above the trestle frame. Arrows demonstrate that the trough is configured to reside within the trough carrier, and the trough carrier is configured to reside within the trestle.

FIG. 2B presents cross-sectional views of the trestle, the trough carrier, and the trough of FIG. 2A. The views are taken across line 2B-2B of FIG. 2A. These views better demonstrate that the trough is configured to reside within the trough carrier, and the trough carrier in turn is configured to reside within the trestle.

FIG. 3 is another side view of the pipe-handling machine of FIG. 2. In this view, the trestle has been raised by a carriage to the top of an inclined ramp. A trough carrier transport mechanism is being used to both raise and translate forward the trough carrier from the trestle. It can be seen that a tubular has been delivered to the rig floor.

FIG. 4 shows a perspective view of a base frame as might be used to provide lateral support to the trestle, in one embodiment. Channels are seen in base frame bars for receiving the rear portion of the trestle.

FIG. 4A presents yet another side view of the pipe-handling machine of FIGS. 1 and 2. In this view, the trestle is back in its lower position. A rear portion of the trestle is being folded over in order to shorten the length of the trestle for transportation. The inclined ramp is also being folded over the trestle. A ramp rotation mechanism is used to rotate the ramp.

FIG. 4B shows a side view of the pipe-handling machine of FIG. 4A. In this view, the rear portion of the trestle has been folded over the trestle, and the inclined ramp has also been folded over the trestle. The pipe-handling machine is now ready for transport to a new rig site.

FIGS. 4C(1)-(3) each show another side view of a portion of the pipe-handling machine of FIGS. 1 and 2. Here, an alternate ramp rotation mechanism is employed for rotating the ramp. In FIG. 4C(1), the ramp is folded over the trestle, while in FIG. 4C(3), the ramp is fully extended. FIG. 4C(2) shows an intermediate position of the ramp.

FIG. 5A provides a side view of the pipe-handling machine of FIG. 2, with the trestle shown in an upper position in order to deliver a joint of pipe onto the drilling rig floor. The rig floor height in this Figure is lower than the rig floor height of FIG. 3. A trough carrier transport mechanism is being used to axially translate the trough carrier from the trestle.

FIG. 5B is a side view of the pipe-handling machine of FIG. 2, with the trestle shown in an upper position in order to deliver a joint of pipe onto the drilling rig floor. The rig floor height in this Figure is higher than the rig floor height of FIG. 5A. A trough carrier transport mechanism is being used to raise the rear end of the trough carrier above the trestle, thereby reducing the angle of the pipe relative to the rig floor.

FIG. 5C presents a side view of a pipe-handling machine having an alternate embodiment for a trough carrier transport mechanism. In this arrangement, the trough carrier transport mechanism is being used to both raise and translate forward the trough carrier from the trestle.

FIG. 6A shows a front view of the frame for the inclined ramp in the pipe-handling machine of FIG. 1. In the arrangement shown in FIG. 6A, modular extensions have been mounted into the frame.

FIG. 6B is a side view of the frame for the inclined ramp of FIG. 6A.

FIG. 7 provides a top view of the frame for the inclined ramp of FIG. 6. Visible in this view is the top of the frame, including portions of a sheave and carriage within the frame.

FIG. 8A is a side view of a trestle transport mechanism as might be incorporated within the frame of FIG. 6A. In this arrangement, the trestle transport mechanism employs telescoping sections that are hydraulically extended. A sheave is incorporated into the trestle transport mechanism. The sheave is shown both in its start position and in its fully elevated position. A dashed line shows the extension of the sheave from its starting position to its elevated position.

FIG. 8B is a schematic view of the trestle transport mechanism of FIG. 8A, shown adjusted for yet a higher start position and a higher fully elevated position than in FIG. 8A. Additional telescoping sections are provided for the trestle transport mechanism.

FIG. 8C is a schematic view of the trestle transport mechanism of FIG. 8A, shown adjusted for yet a higher start position and a higher fully elevated position than the trestle transport mechanism of FIG. 8B.

FIG. 9A presents a novel connector as may be used to connect the chains to the carriage. The connector has not yet received the chain.

FIG. 9B presents the chain connector of FIG. 9A. In this view, the connector has received the chain. A bolt has been driven into position for securing the chain.

FIG. 10A provides a perspective view of a base frame for the trestle for the pipe pickup and laydown machine of the present invention, in one arrangement. The trestle, trough carrier and trough have been removed for purpose of illustration. In this embodiment, two arms are seen—a lifting arm and a stabilizing arm. The arms are affixed to opposite sides of the base frame. In FIG. 9A, the stabilizing arm is affixed near the bottom of the frame on a side.

FIG. 10B presents an alternate arrangement of the trestle base frame of FIG. 9A. In this view, a stabilizing arm is again shown extending from one side of the frame. A lifting arm is also shown on the opposite side of the frame to assist in loading pipe into the trough. In FIG. 9B, the stabilizing arm is affixed near the top of the trestle frame on a side.

FIG. 11 presents a top view of the trough of FIG. 2A. Visible in this view are two pairs of lifting plates. One pair is for ejecting a pipe to one side of the trough, while the other pair is for ejecting a pipe to the other side of the trough.

FIG. 12A provides an enlarged view of two lifting plates. Each lifting plate is mounted within the concave surface of the trough. The plates are used for urging a tubular from within the trough out of the trough. One plate urges the tubular to move to one side of the trough, while the other plate is actuated to move the tubular to the other side, depending on which side of the trough the pipe rack is positioned.

FIG. 12B shows the lifting plates of FIG. 12A in a side, cross-sectional view. The view is taken across line 12B-12B of FIG. 11. In this view, one of the plates has been actuated. It is understood that both plates will not be actuated simultaneously, since the plates are used to urge a pipe towards opposite respective sides of the trough.

FIG. 12C provides another cross-sectional view of the trough of FIG. 11, allowing a fuller view of a pivoted plate. The view is taken across line 12C-12C of FIG. 11.

FIG. 13 provides a circuit diagram for a hydraulic system as might be used during operation of the pipe-handling machine of FIG. 1, in one embodiment.

FIG. 14 provides a circuit diagram for a hydraulic system of the pipe-handling machine of FIG. 1, in an alternate embodiment.

Each of FIGS. **15**A through **15**C presents a top view of a pipe pickup and laydown machine being transferred from a flatbed trailer onto a catwalk at a rig site. The pipe-handling machine and the rig are shown schematically.

In FIG. **15**A, the pipe-handling machine is resting on the flatbed trailer of a truck. The flatbed trailer is positioned adjacent a catwalk of a drilling rig. The bed of the truck and the machine are positioned essentially normal to the catwalk.

In FIG. **15**B, the pipe-handling machine has been rotated to a position essentially parallel to the catwalk using a winch line.

In FIG. **15**C, the pipe-handling machine has been pulled onto the catwalk. A winch line is visible pulling the machine.

Each of FIGS. **16**A through **16**D presents a top view of the pipe pickup and laydown machine of FIGS. **15**A-**15**C. The machine has completed the pipe pick-up and laydown operations, and is now ready to be taken from the drilling site. In these drawings, the machine is being transferred from the catwalk back to the flatbed trailer. The pipe-handling machine and the rig are again shown schematically.

In FIG. **16**A, a winch line has been configured for pulling the machine back onto the flatbed trailer.

In FIG. **16**B the pipe-handling machine has been pulled onto the trailer, but is still oriented perpendicular to the bed.

FIG. **16**C shows the winch line being reconfigured so that the pipe-handling machine can be rotated into proper orientation for transport on the trailer.

Finally, in FIG. **16**D, the pipe-handling machine of FIG. **16**C has been properly positioned on the flatbed trailer, and is ready to be transported away from the drill site.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** presents a perspective view of a pickup and laydown system, or "pipe-handling machine" **100** constructed in accordance with the present invention, in one embodiment. In this view, the pipe-handling machine **100** has been moved to a rig site, and is set up adjacent to a drilling rig **10**. A portion of the drilling rig **10** is visible in FIG. **1**, including the rig floor **12**. The rig **10** shown is a land rig having a rig floor **12** that is between 16 and 30 feet in height above the ground. However, it is understood that the pipe pick-up and laydown machine **100** of the present invention may be used with either land or offshore rigs (not shown), and with rigs of various sizes and configurations. In addition, the pipe-handling machine **100** may be used in connection with any wellbore operation platform which handles pipe. The pipe-handling machine **100** of FIG. **1** is shown somewhat schematically to demonstrate one contextual use for the machine **100**.

The pipe-handling machine **100** is designed to receive a joint of pipe **50** from a pipe rack **195** at ground level, and deliver it to the rig floor **12** for further stacking and use during a drilling or workover operation. Reciprocally, the pipe-handling machine **100** is able to receive pipe **50'** from the rig floor **12**, and return it back to ground level where it can be expelled onto the pipe rack **195**.

FIG. **2** shows a side view of the pipe-handling machine **100** of FIG. **1**. A lower portion of a drilling rig **10** is also shown somewhat schematically to place the machine **100** in context. In the side view of FIG. **2**, two members of the machine **100** are discernable—a trestle **200** and a ramp **500**. Two other members of the machine **100**—a trough carrier **300** and a trough **400**—are disposed within the trestle **200** and are not separately discernable in the views of FIGS. **1** and **2**.

The trestle **200** of the pipe-handling machine **100** serves as a cradle for the machine **100**. In the views shown in FIGS. **1** and **2**, the trestle **200** is in an essentially horizontal position. When situated for operation, the trestle **200** has a forward portion **202** proximate to the drilling rig **10**, and a rear portion **204** distal to the drilling rig **10**. Preferably, the trestle **200** is placed on the top of a catwalk **190** upon delivery to a rig site. Those of ordinary skill in the art will appreciate that most drilling sites, especially those on land, include a catwalk that serves as a staging area for transferring pipe **50** from various pipe racks (such as the pipe rack **195**) to the rig floor **12**. Typically, the catwalk **190** has an elevated solid platform that is of approximately the same height as the pipe racks.

The trestle **200** defines an elongated frame structure having a plurality of structural support members. Various structural support members are seen best in the cross-sectional view of FIG. **2**B. First, longitudinal support members **212** are provided. Longitudinal support members **212** extend along the longitudinal axis of the trestle **200**, on both the top and the bottom of the trestle **200**. The longitudinal support members **212** are seen in FIG. **2**B, in cross-section. The longitudinal support members **212** are secured together by vertical support members **214** and by horizontal frame members **215**. Together, the various support members **212**, **214**, and **215** form an open top, U-shaped truss. Thus, the trestle **200** includes an upper receiving surface, shown at **216** in FIG. **2**B. In one aspect, the upper surface **216** is concave in configuration.

The trestle **200** houses two separate frame members—a trough carrier **300** and a trough **400**. The trough carrier **300** and the trough **400** are not visible in FIG. **1** or **2** as they are nested within the trestle **200**. However, the trough carrier **300** and trough **400** are visible in FIGS. **2**A and **2**B. FIG. **2**A is a side view of the trestle **200** from the pipe-handling machine **100** of FIG. **2**. A trough carrier **300** and trough **400** are shown exploded above the trestle **200**. Arrows demonstrate that the trough **400** is configured to reside within the trough carrier **300**, and the trough carrier **300** is configured to reside within the trestle **200**.

FIG. **2**B presents cross-sectional views of the trestle **200**, the trough carrier **300**, and the trough **400** of FIG. **2**A. The views are taken across line **2**B-**2**B. These views better demonstrate that the trough **400** is configured to reside within the trough carrier **300**, and the trough carrier is configured to reside within the trestle. More specifically, the trough carrier **300** is received upon the upper receiving surface **216** of the trestle **200**, while the trough **400** is received upon an upper receiving surface **316** of the trough carrier **300**. Features of the trough carrier **300** and the trough **400** will be discussed in more detail below.

It is noted at this point that the overall length of the pipe-handling machine **100** is preferably dimensioned to be received upon and transported by a flatbed trailer without necessity of a special DOT permit. In one aspect, and to accomplish a shortening of the overall length of the pipe-handling machine **100**, the rear portion **204** of the trestle **200** may be folded over. The rear portion **204** is folded over by means of a pin connection **206**. In this respect, the rear portion **204** is joined to the trestle **200** by a pin **206** that allows the rear portion **204** to move from a first lower position in the longitudinal plane of the trestle **200**. The pin **206** is seen in FIG. **4**A. In one arrangement, the rear portion **204** is approximately 8 feet in length.

FIG. **4**A presents yet another side view of the pipe-handling machine **100** of FIG. **2**. In this view, the trestle **200** is again in its lower position. The rear portion **204** of the trestle **200** is being folded over in order to shorten the length of the trestle **200** for transportation. Arrow **207** shows progressive rotational movement of the rear portion **204** as it is folded into the trestle **200**.

It is preferred that the pipe-handling machine **100** be positioned on a base frame. A base is shown at **240** in FIG. **2** and FIG. **4**A. The base **240** is shown schematically as a line in FIG. **2**, and is seen placed on top of the catwalk **190**. However, in FIG. **4**, the base **240** is seen in perspective view. In one arrangement, the base **240** comprises a pair of parallel bars **248** that serve as a guide system for the trestle **200**. In this respect, the guide system slidably receives the rear portion **204** of the trestle **200** as the forward end **202** moves upward towards the rig floor **12** during tool **100** operation. Preferably, the guide system bars **248** define parallel channels. Vertical bars **249** are also provided. As will be described later in connection with FIGS. **10**A and **10**B, the vertical bars **249** serve as support members for a stabilizing arm **610** or, alternatively, a lifting arm **620**.

The pipe pick-up and laydown machine **100** next comprises an inclined ramp **500**. In FIGS. **1** and **2**, it can be seen that the ramp **500** is pivotally connected to the trestle **200** at the trestle's front end **202**. The ramp **500** has been inclined against the rig **10**. Preferably, the ramp **500** is supported by a V-Door ramp, as shown at **16** in FIGS. **1** and **2**.

The ramp **500** defines an essentially U-shaped frame **506** made up of a plurality of beams and lattices. Transverse stabilizing members **507** are included in the frame **506**. FIG. **6**A presents a front view of a frame in one embodiment. FIG. **6**B presents the frame of FIG. **6**A in side view. An optional modular extension **511** is shown included in the frame **506**, connected by pads **508**. The modular extensions **511** permit the ramp **500** to be lengthened in order to accommodate rig floors **12** of various heights.

The ramp **500** has an upper end **504** and a lower end **502**. Preferably, the lower end **502** is pivotally connected to a forward end **242** of the base **240** (seen in FIG. **4**). This allows the ramp **500** to be rotated between a folded over position for transport, and an unfolded position for operation. Movement of the ramp **500** between these positions is shown at arrow **507** in FIG. **4**A.

FIG. **3** presents another side view of the pipe-handling machine **100** of FIG. **2**. In FIG. **3**, the inclined ramp **500** is in its extended position against the rig **10**. Preferably, the ramp **500** is rested against an already-in-place V-door ramp **16**. In this view, the trestle **200** has been raised to the top of the inclined ramp **500**. A tubular **50** has been delivered to the rig floor **12**.

Various arrangements may be provided for the pivoting connection between the ramp **500** and the base **240**. In FIG. **3**, one embodiment for a ramp rotation mechanism **510** is provided. The ramp rotation mechanism **510**, is best seen in FIG. **4**A. The ramp rotation mechanism **510** includes at least one hydraulic cylinder **528** and a pair of triangular frames **520**, **530**. The hydraulic cylinder **528** and the triangular frames **520**, **530** are positioned at the lower end **502** of the ramp **500**. The lower end of the ramp **500** is designated in FIG. **2** by reference arrow **502**. As shown in FIG. **2**, the lower end **502** is pivotally pinned to ramp rotation frames **520** (only one shown). The pivoting connection allows the ramp **500** to pivot relative to the trestle **200**.

The ramp rotation frame **520** presented in FIGS. **2** and **4**A is triangular, though other geometries may be employed. The ramp rotation frame **520** resides at the same level as the lower position of the trestle **200**, such as immediately above or on the catwalk **190**. In one arrangement, the hydraulic cylinder **528** (shown most clearly in FIG. **4**B) is placed such that the fixed end of the respective cylinder **528** is pinned to a first point **522** in one of the rotation frames **520**. The cylinder **528** includes a telescoping arm **529** that is pinned to a first point **532** of a separate A-frame **530**. A vortex **534** of the A-frame **530** is pinned to a second point **524** in the ramp rotation frame **520**.

Actuation of the hydraulic cylinder **528** causes the inclined ramp **500** to be moved between extended and retracted positions. As noted above, the ramp **500** is in its extended position in FIGS. **2** and **3**. FIG. **4**A is provided to show the ramp **500** being rotated to its folded over, or retracted position. Again, movement of the ramp **500** from its extended position to its retracted position is shown at arrow **507** in FIG. **4**A. To retract the ramp **500**, the telescoping arm **529** is extended outward from the hydraulic cylinder **528**. FIG. **4**B shows the telescoping arm **529** extended, causing ramp **500** to be folded over the trestle **200**.

FIG. **4**B is a side view of the pipe handling machine of FIG. **4**A. In this view, the rear portion of the trestle **200** has been folded over the trestle **200**, and the inclined ramp **500** has also been folded over the trestle **200**. The foldable features allow the overall length of the machine **100** to be shortened for over-the-road transport purposes. Preferably, the length of the machine **100** in its folded state is less than 45 feet to avoid permitting requirements from a regulatory transportation department.

An alternate arrangement for a ramp rotation mechanism **510'** is shown in FIGS. **4**C(**1**)-(**3**). FIGS. **4**C(**1**), **4**C(**2**) and **4**C(**3**) each shows a side view of the alternate ramp rotation mechanism **510'**. In FIG. **4**C(**1**), the ramp **500** is folded over the trestle **200**, while in FIG. **4**C(**3**), the ramp **500** is fully extended. FIG. **4**C(**2**) shows an intermediate position of the ramp **500**.

In the alternate arrangement shown in FIGS. **4**C(**1**)-(**3**), a pair of frame members **520'**, **530'** is again provided. The first frame member **520'** is triangular, while the second frame member **530'** is integral to the ramp **500** itself. Hydraulic cylinders **528**, **538** sequentially act on the two frame members **520'**, **530'** in order to rotate the ramp **500**. Hydraulic cylinder **528'** acts on the first frame member **520'**, while hydraulic cylinder **538'** acts on the second frame member **530'**.

The first hydraulic cylinder **528'** has a first end **522'** pivotally connected to the trestle **200**, and a second end **524'** pivotally connected to the first frame member **520'**. Likewise, the second hydraulic cylinder **538'** has a first end **532'** pivotally connected to the trestle **200**, and a second end **534'** pivotally connected to the second frame member **530'**. The second hydraulic cylinder **538'** has an intermediate pivoting connection **536'** as well.

Referring to FIG. **4**C(**1**), the first hydraulic cylinder **528'** is fully extended, while the second hydraulic cylinder **538'** is fully retracted. In this position, the ramp **500** is folded over the trestle **200**. In FIG. **4**C(**2**), the first hydraulic cylinder **528'** has been fully retracted, while the second hydraulic cylinder **538'** remains fully retracted as well. In this position, the ramp **500** is being rotated into an upright position. Finally, in n FIG. **4**C(**3**), the first hydraulic cylinder **528'** remains fully retracted, while the second hydraulic cylinder **538'** has been extended. In this position, the ramp **500** is rotated further into a position where it can lean against a V-Door ramp (not shown). The use of separately linked and sequentially operated cylinders **528'**, **538'** allows for a greater angular range of motion for the ramp **500**.

In one embodiment, the ramp **500** is extendable in height. To this end, the ramp **500** is fabricated from modular frame portions **511**, e.g., three or more, that are connectible end-to-end. The addition of modular frame portions (shown at **511** in FIG. **6**A) serves to selectively lengthen the frame **500**, thereby allowing the ramp **500** to be adapted to different rig heights. The drilling company provides the rig height, catwalk, and V-ramp dimensions. This informs the operator of the pipe-handling machine **100** with the information needed to calculate the needed length of the inclined ramp **500**.

As noted in connection with FIGS. **2**A and **2**B, the pipe pick-up and laydown machine **100** also comprises a trough carrier **300**. The trough carrier **300** defines an elongated frame made up of a plurality of beams and lattices. The trough carrier **300** has an open top for receiving a trough **400**. The open top forms an upper receiving surface **316** for receiving the trough **400**. The trough carrier **300** resides within the U-shaped trestle **200** on the upper receiving surface **216**, and is nested between the trestle **200** and the trough **400**.

The trough carrier **300** is connected to the trestle **200** by means of a trough carrier transport mechanism **310**. The trough carrier transport mechanism **310** is provided for selectively moving the trough carrier **300** relative to the trestle **200**. One embodiment of a trough carrier transport mechanism **310** is shown in FIG. **3**. Preferably, the trough carrier transport mechanism **310** defines a hydraulically operated cylinder **312** having at least one telescoping section **314**. The hydraulically operated cylinder **312** is pivotally fastened to the trestle **200** proximate to the rear portion **204** of the trestle **200** by a pin **306**. The hydraulically operated cylinder **312** is oriented so that the telescoping section(s) **314** extend outward towards the forward portion **202** of the trestle **200**. Thus, extension of the telescoping section(s) **314** serves to extend the trough carrier **300** partially out of the trestle **200** and towards the drilling rig **10**. A brace **318** is also provided to assist the telescoping section(s) **314** in lifting the trough carrier **300**. The brace **318** is pivotally pinned to the trestle **200** at one end, and to the telescoping section **314** at the other.

FIG. **3** is another side view of the pipe-handling machine **100** of FIG. **1**. In this view, the trestle **200** has been raised by a carriage **550** to the top of the inclined ramp **500**. The trough carrier **300** can be seen raised relative to the trestle **200**. The trough carrier transport mechanism **310** is being used to both rotationally raise and translate forward the trough carrier **300** from the trestle **200**. It can also be seen in FIG. **3** that a tubular **50** has been delivered to the rig floor **12**.

A variety of embodiments is possible for the trough carrier transport mechanism **310**. Three additional embodiments are shown in FIGS. **5**A, **5**B and **5**C, respectively.

First, FIG. **5**A provides a side view of the pipe-handling machine **100** of FIG. **2**, with the trestle **200** shown in an upper position in order to deliver a joint of pipe **50** onto the drilling rig floor **12**. The joint of pipe **50** could be drill string, casing, production tubing, or any other type of jointed tubular. The rig floor height in this Figure is lower than the rig floor height of FIG. **3**. A trough carrier transport mechanism **310**A is being used to axially translate the trough carrier **300** from the trestle **200**. Here, the trough carrier transport mechanism **310**A simply employs a hydraulically operated cylinder **312**A to extend the trough carrier **300** along the longitudinal plane of the trestle **200**.

Next, FIG. **5**B presents a side view of the pipe-handling machine **100**, with the trestle **200** again shown in an upper position in order to deliver a joint of pipe **50** onto a drilling rig floor **12**. The rig floor height in this Figure is higher than the rig floor height of FIG. **5**A. Here, a trough carrier transport mechanism **310**B is used to raise the trough carrier **300** from the trestle **200**. The trough carrier transport mechanism **310**B employs a hydraulically operated cylinder **312**B to extend the rear portion of the trough carrier **300** directly upward relative to the trestle **200**. The angle of approach for the pipe **50** towards the drilling rig floor **12** is thereby lessened.

FIG. **5**C presents a side view of a pipe handling machine **100** having yet another alternate embodiment for a trough carrier transport mechanism **310**C. In this arrangement, the trough carrier transport mechanism **310**C is being used to both raise and translate forward the trough carrier **300** from the trestle **200**. Here, the trough transport mechanism **310**C employs a hydraulically operated cylinder **312**C to extend the trough carrier **300** forward relative to the trestle **300**. At the same time, the cylinder **312**C is pivotally pinned to a fixed-length brace **316**C that causes the trough carrier **300** to also extend upward. The brace **316**C is preferably attached to the trough carrier **300** at the same pivot point as the telescoping cylinder **312**C. The brace **316**C has a lower end that will slidingly engage the trough carrier **300**. In the retracted position, the brace **316**C will be nearly parallel with the longitudinal axis of the trestle **200**, and the trough carrier **300** will be parallel with the trestle **200**. When the hydraulic cylinder **312**C begins to extend, it first moves the trough carrier **300** and the brace **316**C forward relative to the trestle **200**. The forward end of the brace **316**C will eventually hit a stop **216**C, causing the brace **316**C to rotate upward, pivoting the trough carrier **300** upward relative to the trestle **200**. In this way, full extension of the trough carrier **300** may be achieved while also reducing the angle of approach for the nested pipe **50**.

As noted, the pipe pick-up and laydown machine **100** also comprises a trough **400**. The trough **400** defines an elongated frame configured to cradle a pipe section, such as a drill pipe **50** or other pipe employed in drilling a well. In one arrangement, the trough **400** is fabricated from a set of six elongated beams (shown at **408** in FIG. **2**B and FIG. **12**C) welded side-by-side to form an essentially concave upper receiving surface **416**. The affixed beams **408** are seen in the cross-sectional view of FIG. **2**B. The trough **400** is longitudinally movable relative to the trough carrier **300**. A trough transport mechanism **410** is provided for selectively moving the trough **400** along the trough carrier **300**, and then retracting the trough **400** back into the trough carrier **300**. Preferably, the trough transport mechanism **410** also defines a hydraulically operated cylinder **412**C (seen in FIG. **5**C) having at least one telescoping section **414**C. The hydraulically operated cylinder **412**C is fastened to the trough carrier **300**, and is oriented so that the telescoping section **414**C extends outward towards the drilling rig **10**. Thus, extension of the telescoping section **414**C serves to extend the trough **400** partially out of the trough carrier **300** and towards the drilling rig **10**. Of course, other means for sliding the trough **400** relative to the trough carrier may be employed.

At this point, it should be noted that there is significant advantage to employing both a trough carrier transport mechanism **310** and a trough transport mechanism **410**. Those of ordinary skill in the art will appreciate that if pipe **50** were moved onto the rig floor **12** using only the trough **400** and trough transport mechanism **410**, the extent of reach over the rig floor **12** would be more limited, e.g., approximately eight feet. However, when the pipe **50** is delivered with the additional support of the trough carrier **300** and the additional reach of the trough carrier transport mechanism **310**, pipe **50** may be delivered an additional eight feet over the rig floor **12** for a net delivery of 16 feet. In addition, heavier pipe, such as 10 inch drill collars, may be delivered.

As can be seen in FIG. **3**, as well as in each of FIGS. **5**A, **5**B and **5**C, the front end **202** of the trestle **200** is carried upwards toward the rig floor **12** along the inclined ramp **500**. The connection between the front end **502** of the trestle **200** and the ramp **500** is by means of a carriage **550**. The carriage **550** is designed to transport the forward end **202** of the trestle **200** between the upper **504** and lower **502** ends of the ramp **500**. In one arrangement, the carriage **550** comprises a U-shaped channel body that has rollers (not shown) on opposite ends. Front and side views of the carriage **550** can be seen in FIGS. **6**A and **6**B, respectively.

It is desirable that the pivoting connection between the trestle **200** and the carriage **550** be removable. In this respect, it may be necessary to lift the entire pipe-handling machine **100** onto a catwalk on an offshore platform (not shown). Offshore rigs have a crane-lifting capacity, such as 20,000 pounds. However, the combined trestle **200** (and nested trough carrier **300** and trough **400**) and ramp **500** will, in one embodiment, weigh approximately 28,000 pounds. Out of this total weight, the ramp **500** and carriage **550** and accompanying parts, e.g., chains **517**, will account for about 10,000 pounds. Releasable connecting pins **536** (shown in FIGS. **4**A and **7**) are used for the pivoting connection between the trestle **200** and the carriage **550**.

FIG. **7** demonstrates a top view of the frame of FIG. **6**A. Visible in this view is the top of the frame **506**, including portions of a sheave **518** and the carriage **550**. The rollers of the carriage **550** are received in oppositely-facing U-shaped channel tracks **554** that are secured in spaced relation within the carriage **550** by suitable transverse members, such as plate **558**. The carriage **550** has ears **556** which receive pins **536** for pivotally mounting the trestle **200** to the carriage **550**. The carriage **550** is connected to a pair of chains **517** rove over a pair of spaced sheaves **518** mounted on the end of telescoping section **514** of the trestle transport mechanism **570**. The pair of sheaves **518** is positioned within the U-shaped channel that defines the carriage **550**. One end of the chains **517** is secured to the frame **500** at an anchor point on the side proximate to the drilling rig **10**. The other end of the chains **517** is secured to the carriage **550** by a suitable pin or other securing means (not shown). The result is that for every foot of lift accomplished by extension of the trestle transport mechanism **570**, the carriage **550** is lifted two feet.

The two-to-one ratio of extension-to-lift provided in the present ramp **550** means that the anchor point for the chain **517** must be at approximately the halfway point up the frame **506**. Thus, the anchor point is adjustable. The adjustable nature of the ramp **500** and the anchor point is demonstrated in FIGS. **8**A-**8**C. FIG. **8**A presents a schematic view of the trestle transport mechanism **570**. The sheave **518** is shown both in a start position and in a fully elevated position. The carriage **550** is translated by one or more chains **517**. The chains **517**, in turn, are rove by the sheaves **518** at the top of the last telescoping section **514**. As the telescoping section **514** is extended from the hydraulic cylinder **512**, the sheave **518** is raised. This has the effect of expediting the lifting of the carriage **550** and attached trestle **200**.

It can also be seen in FIG. **7** that a second pair of rollers **519** is provided inside the carriage rollers **554**. More specifically, rollers **519** serve to guide the telescoping cylinders **514** of the trestle transport mechanism **570** as the cylinders **514** are raised along the ramp **500**.

FIG. **9**A presents a novel connector **580** as is preferably used to connect one of the chains **517** to the carriage **550**. The connector **580** generally comprises a bracket **582** having an opening **584** for receiving the chain **517**. The bracket **580** shown in FIG. **9**A is generally U-shaped. A fastening bolt **586** is movably connected to the bracket **582**. The bolt **586** has a first end external to the bracket **582**, and a second end (not seen) within the opening **584** for selectively engaging and releasing the chain **517**. Preferably, the bolt **586** is threadedly received within a mating threaded opening **588** in the bracket **580**. Movement of the fastening bolt **586** is accomplished by turning the bolt **586**.

The novel connector **580** allows the point of connection between the carriage **550** and the chain **517** to be quickly adjusted, depending upon the number of extensions to be added to the ramp frame. Stated another way, the anchor point for the chain **517** is more easily adjustable. Any excess chain length is gathered within the frame **506**, or may be allowed to simply dangle.

In FIG. **9**A, the chain **517** has not yet been inserted into the connector **580**. It can be seen that in the arrangement of FIG. **9**A, the chain **517** is received through a pair of grooved bars **583**. The position of the upper bar is adjustable in response to movement of the bolt **588**.

FIG. **9**B presents a perspective view of the chain connector **580** of FIG. **9**A, with the chain **517** being received within the bracket **582**. The bolt **586** has been tightened into the bracket **582**. Movement of the bolt has caused the upper bar **583** to clamp the chain **517**.

FIG. **8**B provides another schematic view of the trestle transport mechanism **570**. Here, the anchor point is adjusted for a higher start position and a higher fully elevated position than in FIG. **8**A. FIG. **8**C provides an additional schematic view of the trestle transport mechanism **570**, shown adjusted for a still higher start position and still higher fully elevated position.

In operation, the hydraulic cylinder **522** for the ramp **500** is actuated so as to retract the corresponding telescoping arm **524**. This causes the ramp **500** to be raised from its nested position within or immediately above the trestle **200**. The ramp **500** is preferably positioned against an already-existing V-Door ramp for support. For safety reasons, the top **504** of the frame **506** should be tied to the rig floor **12** at this point before any joints of pipe **50** are picked up.

The hydraulic cylinder **512** of the ramp **500** is next actuated so as to extend the telescoping arms **514** from hydraulic cylinder **512**. This serves to lift the carriage **550** upward along the ramp **500**. As the telescoping sections **514** are extended, the carriage **550** travels up the frame **506** of the ramp **500**. The carriage **550** has a starting point at the level of the catwalk **190**. Because of the 2:1 ratio of travel time, the carriage **550** is able to “catch up” to the height of the extended telescoping sections **514** at the height of the rig floor **12**.

As noted, the forward portion **202** of the trestle **200** is pivotally pinned to the carriage **550**. The carriage **550** has ears **556** which receive pins **536** for pivotally mounting the trestle **200** to the carriage **550**. Rollers (not shown) are positioned within the frame **500** on either side of the trestle **200**. The rollers ride within the guide system for the carriage **550** defined by the frame **506**. As the carriage **550** is raised along the ramp frame **506** the rollers travel upward along the frame **500** inside oppositely-facing channels **554**. The forward portion **202** of the trestle **200** is thus raised to a level at or above the rig floor **12**.

An additional optional feature of the trestle **200** is a pair of articulating legs **230**. The articulating legs **230** are pinned to the rear portion **204** by pins **209**. Attachment of one of the articulating legs **230** to the trestle **200** by pin **209** is seen in FIG. **4**A. The articulating leg **230** is slightly shorter than the rear portion **204** of the trestle **200**. As shown in FIGS. **2** and **4**A, the articulating leg **230** in one embodiment defines a triangular truss type member having an upper hypotenuse leg **235** and a slightly shorter base leg **234**. A third leg **236** connecting the base **234** and hypotenuse **235** legs is a much shorter leg. The shorter leg **236** connects the ends of the legs **234**, **235** to form the triangular articulated leg **230**.

Each upper leg **234** is pinned to the back portion of the trestle **200** by pins **209**. The base **234** and hypotenuse **235** legs, in turn, each meet at a pin which carries a roller **246**. The rollers **246** move in a track **248** (seen best in FIG. **4**) along the base **240**.

FIG. **4** presents a perspective view of a base structure **240** as might be used to support the trestle **200**, and to pivotally connect to the ramp **500**. A front portion **242** connects to the ramp **500**, while a rear portion **244** connects to the trestle **200**. As shown in FIG. **4**, the base **240** in one arrangement defines two parallel tracks **248**. The track **248** serves as a guide system for the trestle **200** as it is moved. The track **248** includes a pair of stop members **248'** (shown in FIGS. **3** and **4**) at the forward end of the rear portion **204** of the trestle **200**. The stop members **248'** limit the forward movement of the rollers **246** on the articulating legs **230**. When the front end **202** of the trestle **200** is raised along the inclined ramp **500** into the raised position shown in FIG. **3**, the back end **204** of the trestle **200** is first moved forward until the rollers **246** engage the stops **248'**. From there, the articulating legs **230** pivot so as to cause the rear portion **204** of the trestle **200** to be raised. With this arrangement, no independent vertical assist is required to lift the back end **204** of the trestle **200**. Raising the back end **204** of the trestle **200**, in turn, reduces the approach angle of the pipe joints **50** as they are delivered to or removed from the rig floor **12**.

Various other arrangements for pivotally lifting the rear portion **204** of the trestle **200** may be provided. Exemplary arrangements are provided in U.S. Pat. No. 4,403,898 issued to Thompson on Sep. 13, 1983. The '898 Thompson patent is incorporated herein in its entirety, by reference.

It is desirable to provide a means for loading pipe **50** from the pipe racks into the trough **400** of the machine **100**, and vice versa. Accordingly, a loading apparatus **600** is optionally provided. The loading apparatus **600**, in one arrangement, is shown in FIG. **10**A. FIG. **10**A provides a perspective view of a trestle **200** for the pipe pickup and laydown machine **100** of the present invention, in one arrangement. The trough carrier **300** and trough **400** have been removed for purpose of illustration. In this embodiment, two arm are seen—a lifting arm **620**; and a stabilizing arm **610**. The arms **620**, **610** are affixed to opposite sides of the trestle **200**. More specifically, the arms **620**, **610** are affixed vertical frame members **249** from the trestle support frame **240**.

First, the loading apparatus **600** employs at least one lifting arm **620**. The lifting arm **620** shown in FIG. **10**A is disposed on a side of the trestle frame **240**, i.e., affixed to vertical structural support member **249**. In this way, the arm **620** may readily access pipe **50'** on the pipe racks adjacent the catwalk **190**. Optionally, additional lifting arms **620** may be disposed on each side of the trestle **200**. In this manner, a lifting arm **620** can receive pipe on one side of the trestle **200** during the pick-up phase, and deliver pipe to the opposite side of the trestle **200** during the laydown phase.

The lifting arm **620** is preferably hydraulically operated. First, a cylinder may be actuated to translate the arm **620** up and down along the sides of the trestle **200**. The lifting arm **620** typically lifts transverse to the trestle **200** (as shown), or may be configured to rotate along the longitudinal plane of the trestle **200** (arrangement not shown). The lifting arm **620** also includes, in one arrangement, a hydraulic cylinder **622** that receives a telescoping section **624**. This allows the arm **620** to be moved into lifting position.

An upwardly facing concave hand **626** is disposed at the distal end of the telescoping section **624**. The concave hand **626** is positioned under the first pipe **50'** for lifting. Using the cylinder **622** and telescoping section **624** for the lifting arm **620**, the hand **626** may be selectively angled inwards toward the trough **400**. The lifting hand **626** may also be lowered to a position lower than the base of the trestle **200**. The lifting arm **620** is simultaneously raised to a position so that the pipe **50'** rolls off the hand **626** and into the trough **400**. In FIG. **10**A, rotational movement of the lifting hand is shown by arrow **607**.

The loading apparatus **600** optionally further comprises one or more stabilizing arms **610**. In the arrangement shown in FIG. **10**A, a single stabilizing arm is **610** likewise disposed on a side of the trestle frame **240** to access pipe **50"** on the pipe racks.

The stabilizing arm **610** in one arrangement includes a hydraulic cylinder **612** for receiving a telescoping section **614**. The fixed end of the cylinder **612** may be attached proximate the top of the support member **249** (as shown in FIG. **10**A), or proximate the bottom of the support member **249** (as shown in FIG. **10**B). A downward facing concave hand **616** is disposed at the distal end of the telescoping section **614**. The concave hand **616** is positioned over a second pipe **50"** on a pipe rack before a first pipe **50'** is lifted. This provides the stabilizing function.

It should be noted that the concave hand **616** of the stabilizing arm **620** may be turned over and used as a lifting arm. Thus, in one arrangement, it is not necessary to employ both stabilizing arm **610** and lifting arm **620**.

The loading apparatus **600** also employs a pair of pipe loading arms. For purposes of clarity, the loader arms are not shown in FIG. **10**A or **10**B, though it is understood that they are present. However, the loader arms are seen at **630** in FIGS. **2** and **4**C(**1**)-(**3**). Each of the pipe loading arms **630** includes a rotating arm **632** that rotates along the longitudinal axis of the trestle **200**. The arms **630** also each include a hand **636** that extends transverse to the respective rotating arms **632** in order to engage pipe **50'**. Rotation of the rotating arms **632** is accomplished by selectively actuating a hydraulic cylinder and telescoping section (not shown) within the trestle **200**. Actuation of the pipe loading arms **630** allows the arms to catch pipe **50'** within the lifting arm **620**, raise the pipe **50'** upwards to the top of the trestle **200**, and drop the pipe **50'** into the trough **400**.

The loader arms **632** begin in the down position when bringing pipe **50** over to the side of the machine **100**. The arms **632** then rotate upward and carry the pipe **50** to the top of the trestle frame **200** where the pipe **50** rolls off the loader hand **636** and into the trough **400**. The loader arms **632** remain in a raised position as the trestle **200** is elevated by the carriage **550** throughout the raise and lower cycles.

An additional optional feature provided for the machine **100** is a means for causing pipe **50** within the trough **400** to be expelled. When laying down pipe **50**, the trestle **200** is lowered to a horizontal position. The pipe **50** contained within the machine **100** is then rolled out of the trough support members **408** and onto the lifting hands **626** as discussed above. One arrangement for ejecting pipe **50** from a trough is described in col. 4 of the '898 Thompson patent, and shown in FIG. **3** of that patent. However, for the present machine **100**, FIGS. **11**-**12**C illustrate a preferred mechanism for lifting pipe **50** out of the trough receiving surface **416** while it is in the horizontal position so as to cause the pipe **50** to roll onto a pipe rack.

Referring now to FIG. **11**, FIG. **11** presents a top view of the trough of FIG. **2**A. Visible in this view are two pairs of lifting plates **250'**, **250"**. One pair of lifting plates **250'** is in a retracted position, while the other pair **250"** is in an extended position. The preferred pipe transfer mechanism **250** employs these pairs of lifting plates **250'**, **250"** for ejecting pipe (not shown in FIG. **11**) from the trough **400**.

FIG. **12**A provides an enlarged view of a lifting plate **250'** and a second lifting plate **250"**. Each lifting plate **250'**, **250"** is mounted within the concave surface of the trough **400**. The lifting plates **250'**, **250"** each define a central portion **252**, and left and right opposing wings **254** extending away from the central portion **252**. Wings **254** incline upward from the central portion **252** so that they are flush with the inclined sides of the trough **400**. While in the retracted position, the central potion **252** is flush with the lower central portion of the trough **400**. In the extended position, the wings **254** extend above the top plane of the trough **400**.

FIG. **12**B shows the lifting plates **250'**, **250"** of FIG. **11** in a side, cross-sectional view. The view is taken across line **12**B-**12**B of FIG. **11**. Each lifting plate **250'**, **250"** is pivotally mounted by a respective pivot point **256**. The pivot point **256** may be at one end of the plate (**250'** or **250"**) as shown in FIG. **12**B, or may be centrally located under the central portion **252**. A hydraulic cylinder **262** pivots the lifting plates **250'**, **250"** between their retracted and extended positions. The cylinders **262** are fixed at one end **266**. At the opposite end, a telescoping section **264** is pinned to a plate arm **268**. The plate arm **268** pivots about the plate pivot point **256**, thereby pivoting the respective plates **250'**, **250"** themselves. In FIG. **12**B, lifting plate **250'** is shown in its extended position. It is understood that only one of the two plates **250'**, **250"** would be actuated or extended at any given time.

The wings **254** of the plates **250'**, **250"** have angled edges. When the plates **250'**, **250"** are rotated, an upper edge **255** of the plates **250'**, **250"** rises above the upper edges of the trough **400**. FIG. **12**C provides a cross-sectional view of the trough **400**, allowing a fuller view of a pivoted plate **250'**. The view is taken across line **12**C-**12**C of FIG. **11**. It can be seen that the upper edge **255** is inclined toward one side of the trough **400**. This causes the cradled pipe (not shown in FIG. **12**C) to roll to the right. In FIG. **12**C, the leading edge **255** is higher on the left wing portion **254**L than on the right wing portion **254**R.

As noted, two pairs of lifting plates are preferably employed. The leading edge of one pair will cause the pipe to roll to the left, while the leading edge of the other pair will cause the pipe to roll to the right. In this way, pipe **50** may be ejected to either side of the trestle **200**. Furthermore by operating both right and left lifting plates **250"**, **250"**, a pipe **50** can be rolled across the trough **400** from one, pipe rack to another.

It is preferred that the pipe pick-up and laydown machine **100** be completely hydraulically controlled. Those of ordinary skill in the art will appreciate that the presence of electrical components near a working drilling rig creates a risk of fire and explosions. Therefore, a purely hydraulic system is demonstrated herein.

In the hydraulically operated system **700**, a large reservoir of oil is needed. Further, a set of pilot lines and a set of fluid lines directed to the various hydraulically actuated cylinders are required. In addition, a pump, such as a diesel-powered, pressure compensated, piston pump, is required. The pump provides pressure to feed oil into the various fluid lines and cylinders. Finally, valves are employed to direct fluid through the appropriate lines. These components of a standard hydraulic control system are not shown.

Separate circuits are utilized for the various hydraulic operations. These separate circuits are controlled through joysticks provided on an operator's panel **705**. Preferably, the panel **705** is placed on the rig floor **12** to be operated by drilling personnel.

For the present machine **100**, a novel hydraulic circuitry **700** is implemented. FIG. **13** provides an exemplary circuit diagram for the hydraulic system **700** of the pipe-handling machine **100**. The hydraulic system **700** integrates three separate circuits. Those comprise a trestle transport mechanism circuit **710**, a trough transport mechanism/pipe transfer circuit **720**, and a trough carrier transport mechanism/pipe loading circuit **730**. The three circuits are operated through the panel **705**.

It can be seen that a first dedicated circuit **710** is provided for the trestle transport mechanism **210**. This is a reference to the hydraulic cylinder **512** employed to lift the carriage **550**. The carriage **550**, in turn, lifts the forward end **202** of the trestle **200**.

A second circuit **720** is provided for two alternative functions. The functions are the trough transport mechanism **410** and the pipe transfer mechanism **250**. The trough transport mechanism **410** is a reference to the mechanism **410** used to manipulate the trough **400**. In the arrangement shown in FIG. **5**C, this comprises cylinder **412**C and telescoping section **414**C. The pipe transfer mechanism **250** is a reference to the plates **250'**, **250"** employed to eject a pipe **50** from the trough **400**, and associated hydraulic hardware, e.g., cylinders **262** and telescoping sections **264**.

It should be appreciated that an operator would not employ the pipe transfer cylinders **262** while the trough **400** is being raised or extended. At the same time, the operator would not want to extend the trough **400** while pipe **50** is being ejected by the pipe transfer system **250** on the ground. Therefore, a lockout feature is designed into the hydraulic circuitry **700**.

To ensure that one of the mechanisms **410**, **250** is locked out while the other is engaged, mechanical positioning valves **742**, **744** are provided along the ramp **500** proximate to the top **502** and bottom **504** ends, respectively. When the trestle **200** is on the catwalk **190**, a lower position valve (shown schematically at **742** in FIG. **13**) directs the flow of hydraulic power to the pipe transfer system **250**. When the trestle **200** is raised off the catwalk **190** and reaches the end of its travel at the top of the ramp **500**, it activates an upper position valve (shown schematically at **744** in FIG. **13**). The upper valve directs the flow of hydraulic power in the second circuit to the trough transport mechanism **410**. Thus, a safety feature is built into the hydraulic circuitry **700**.

A similar safety arrangement is provided with a third circuit **730**. In this respect, a third circuit **730** is provided that also serves two functions. The third circuit **730** alternatively provides hydraulic power to the trough frame carrier transport mechanism **310** and to the pipe loading apparatus **600**. The trough frame carrier transport mechanism **310** is a reference to the trough carrier transport mechanism **310** used to manipulate the trough carrier **300**. This includes, in the arrangement shown in FIG. **5**C, the cylinder **312**C the brace **314**C, and other features described above. The pipe loading apparatus **600** is a reference to the loading arms **630** and the lifting arms **620**, which work together to load pipe **50'** from the pipe racks into the trough **400**.

It should be appreciated that an operator would not employ the cylinders **312** for the trough carrier transport mechanism while pipe **50** is being loaded into the trough **400** at the catwalk **190**. Reciprocally, the operator would not want to operate the lifting arms **620** while the trestle **200** and nested trough carrier **300** and trough **400** are raised. Therefore, these two circuits are also mutually exclusive. To ensure this, the mechanical positioning valves **742**, **744** also operate to direct the flow of hydraulic fluid to the proper systems **310** or **600**. When the trestle **200** is on the catwalk **190**, the lower position valve directs the flow of hydraulic power in the third circuit **730** to the pipe loading system **600**. When the trestle **200** is raised off of the catwalk **190** and reaches the rig floor **12**, the upper position valve **744** directs the flow of hydraulic power in the third circuit **730** to the trough frame transport mechanism **310**. Thus, a safety feature is again built into the hydraulic circuitry **700**.

The only time during normal operations (i.e. not test or emergency) when the carrier **300** and trough **400** may be extended and retracted is when the upper position valve **744** is reached. At all other times, their movement is prevented by hydraulic interlocks. While the trestle **200** is in the raised condition, the lifting arms **620** and the cylinders **262** for rotating the ejection plates **250'**, **250"** remain hydraulically disabled in the up position.

The three circuits **710**, **720**, **730** described above are controlled through joysticks or other levers on the panel **705**. Separate joysticks are provided for the three circuits **710**, **720**, **730**. Pilot lines connect the panel to fluid exchange valves. This means that a fluid exchange valve is provided for each of the three circuits **710**, **720**, **730**, and is powered by the pilot lines. The fluid exchange valves selectively direct oil from a high pressure oil supply. In a first position, oil is sent through a fluid line to actuate the corresponding telescoping sections outward. In a second position, the fluid exchange valves are neutral such that no fluid flows through the fluid lines for the respective system. And in the third position, the fluid exchange valves direct fluid to retract the various telescoping sections of the respective cylinders.

In the preferred arrangement, a separate, manually powered system is used to control other cylinders in the machine **100**. For example, the stabilizer arms **610** are controlled directly at the pipe racks. Likewise, cylinder **528** is controlled directly for folding the ramp **500** over the trestle **200**. Hydraulic circuitry for these systems is not shown. However, based upon the present disclosure, implementation of these systems could be accomplished by one of skill in the art.

To raise a pipe joint within the trough **400** to the rig floor **12**, the operator moves the control valve joystick for the trestle transport mechanism circuit **710**. Once the trestle **200** clears the upper diverter valve **744** at the top of the ramp **500**, the operator may then operate the trough carrier transport mechanism **310** and trough transport mechanism **410**, as needed, utilizing the joysticks for the second **720** and third **730** circuits, respectively. After the elevator and pipe are clear above the rig floor **12**, the pick-up and laydown machine **100** operator retracts both the carrier **300** and trough **400** within the trestle **200**. The trestle **200** is then lowered along the ramp **500** operating the trestle transport mechanism circuit **710**. As the trestle **200** lowers to the catwalk **190**, the lower fluid diverter valve **742** is released, hydraulically locking the carrier **300** and trough **400** from any further motion until the trestle **200** is again raised up to the rig floor **12**.

As noted, removal of pipe **50** from the trough **400** is accomplished by actuating the cylinders **262** that cause the lifting plates **250'** or **250"** to pivot. In one arrangement, enablement is provided not only by the lower position valve **742** actuated by placing the trestle **200** in its lower position, but also by requiring that the stabilizing arm **610** be in its down position. Both conditions may be required. FIG. **14** shows a more detailed view of a hydraulic circuit as might be employed in the pipe-handling machine **100** of the present invention. Under this circuit, the pick-up and laydown machine **100** operator lowers the stabilizer arms **210** using his joystick control. He then operates the ejection cylinders **262** to eject the pipe **50** from the trough **400** to the lifting hands **626** in the ready to load position. From there the pipe **50** may be removed.

A novel method for delivering and for removing a portable pick-up and laydown machine **100** is also provided herein. The present machine **100** is highly portable, being capable of being transported on a flat-bed trailer. To perform the delivery and removal operations, the flat-bed trailer is outfitted with a "fifth wheel." A fifth wheel **180** comprises a shaft extending vertically above the bed of the trailer, and a nut or other fastening device which is received onto the shaft. The fastening device is a large, radial body having a cutout around an approximate 20 degree arc, thereby leaving an opening for receiving the shaft.

A winch **175** is further employed for rotating and moving the machine **100** to and from the catwalk **190**. The winch **175** may be an 8,000 pound rated winch capable of being moved to different locations around the trailer **185**. It is understood that trailers typically have slots disposed at two-foot intervals around the perimeter of the bed for receiving fasteners and tools, such as a portable winch.

FIG. **15**A is a top, schematic view of a machine **100** of the present invention, resting on a flatbed trailer **185** as might be pulled by a truck **182**. The trailer **185** is positioned adjacent the catwalk **190** of a drilling rig **10**. The trailer **185** with the machine **100** transported thereon is positioned essentially normal to the catwalk **190**.

FIG. **15**B is a top, schematic view of the machine **100** of FIG. **15**A. In this view, the machine **100** has been rotated to a position essentially parallel to the catwalk **190**. To accomplish this, the fastening member (not shown) is loosened from the shaft **180** of a fifth-wheel arrangement. This releases the machine **100** from the fifth-wheel connection, while still allowing the machine **100** to pivot about the shaft **180**. A wireline **195** (or other winch line) is extended from the forward end of the machine **100**, and wrapped around a fixed portion **192** of the V-Door ramp **194**. The wireline **195** is then pulled by the winch **175** so as to rotate the machine **100**. Arrow **197** demonstrates the direction of rotation of the machine **100**.

FIG. **15**C demonstrates the machine **100** having been moved into set-up position. In this respect, the machine **100** has been released completely from the fifth wheel connection. The wireline **195** has then been pulled further by the winch **175** so as to draw the machine **100** completely onto the catwalk **190**. Arrow **107'** demonstrates linear movement of the machine **100** onto the catwalk **190**.

FIG. **16**A is a top, schematic view of the machine **100** of FIG. **15**A. The machine **100** has completed the pipe pick-up and laydown operations, and is now ready to be taken from the drilling site. This means that all components of the machine **100**, such as the ramp **500**, are nested within or upon the trestle **200**. To remove the machine **100** from the catwalk **190**, the winch **175** is moved to a side position on the trailer **185** in the longitudinal plane of the machine **100**. The wireline **195** is wound from the winch **175** and around a center point of the machine **100**. The wireline **195** is then taken up by the winch **175** so as to draw the machine **100** onto the trailer **185**.

FIG. **16**B presents the machine **100** of FIG. **16**A having been pulled onto the trailer **185**. The machine **100** is perpendicular to the trailer **185** and must be rotated before it can be transported. Arrow **107'** again indicates the linear movement of the machine **100**.

FIG. **16**C is a top, schematic view of the machine **100** of FIG. **16**B, with the winchline **195** having been reconfigured. In this respect, the winchline **195** is now tied to the forward end of the machine **100**. The machine **100** is engaged with the shaft **180** of the fifth wheel so as to form a pivot point on the trailer bed **185**. The machine **100** can now be rotated into proper orientation for transport on the flatbed trailer **185**.

In FIG. **16**D, the machine **100** has been rotated by the winchline **195** so as to be property positioned on the trailer **185** for transport. Arrow **107** indicates rotational movement of the machine **100**.

While the foregoing is directed to some embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

The invention claimed is:

1. A pipe-handling machine for manipulating joints of pipe at a rig site, pipe-handling machine comprising:

an elongated trough having a first end, a second end, and an upper receiving surface, the upper surface being configured to receive a joint of pipe, and wherein the elongated trough is configured to support a majority of the joint of pipe along the pipes longitudinal axis;

an elongated trough carrier, the elongated trough carrier having a first end, a second end, and an upper receiving surface, the upper surface of the elongated trough carrier being configured to receive the elongated trough and allow the elongated trough to move longitudinally relative to the elongated trough carrier;

an elongated trestle having a first end, a second end, and an upper receiving surface, the upper surface of the elongated trestle being configured to receive the elongated trough carrier and allow the elongated trough carrier to move relative to the elongated trestle;

a carriage connectible to the first end of the elongated trestle;

an inclined ramp having a first end, a second end, and a guide system therebetween, the guide system slidably receiving the carriage; and

a trestle transport mechanism for transporting the first end of the elongated trestle from the first end of the inclined ramp to the second end of the inclined ramp.

2. The pipe-handling machine of claim **1**:

wherein the pipe-handling machine further comprises a base having a first end, a second end, and a second guide system therebetween, the second guide system slidably receiving the elongated trestle at the second end of the elongated trestle;

and wherein the first end of the inclined ramp is pivotally connected to the base proximate the first end of the base.

3. The pipe-handling machine of claim **2**, wherein the trestle transport mechanism is hydraulically actuated.

4. The pipe-handling machine of claim **3**, further comprising a trough transport mechanism for slidably moving the elongated trough axially along the upper surface of the elongated trough carrier.

5. The pipe-handling machine of claim **4**, wherein the trough transport mechanism is hydraulically actuated.

6. The pipe-handling machine of claim **5**, further comprising a trough carrier transport mechanism for moving the elongated trough carrier relative to the upper surface of the elongated trestle.

7. The pipe-handling machine of claim **6**, wherein the trough transport mechanism is hydraulically actuated.

8. The pipe-handling machine of claim **7**, wherein the trough carrier transport mechanism moves the elongated trough carrier axially along the upper surface of the elongated trestle.

9. The pipe-handling machine of claim **7**, wherein the trough carrier transport mechanism causes the second end of the elongated trough carrier to be lifted upwards above the upper surface of the elongated trestle.

10. The pipe-handling machine of claim **7**, wherein the trough carrier transport mechanism both moves the elongated trough carrier axially along the upper surface of the elongated trestle, and causes the second end of the elongated trough carrier to be lifted upwards above the upper surface of the elongated trestle.

11. The pipe-handling machine of claim **2**,

wherein the elongated trestle further comprises an articulating leg, the articulating leg having a first point pivotally connected to the elongated trestle proximate to the second end of the elongated trestle, and a second point that rides within the guide system of the base;

the guide system of the base further comprises a stop member intermediate the first and second ends of the base;

whereby the second point of the articulating leg contacts the stop member as the first end of the elongated trestle is carried up the inclined ramp, thereby causing the second end of the elongated trestle to be raised upward above the base.

12. The pipe-handling machine of claim **2**, wherein the inclined ramp is comprised of at least three modules for increasing the length of the inclined ramp.

13. The pipe-handling machine of claim **12**, wherein the trestle transport mechanism comprises:

a hydraulic cylinder disposed along the inclined ramp, the hydraulic cylinder having at least one telescoping section;

a sheave disposed at the end of the at least one telescoping section of the hydraulic cylinder; and

a chain connected to the carriage, the chain riding over the sheave as the carriage is moved from a point proximate the first end of the inclined ramp to a point proximate the second end of the inclined ramp.

14. The pipe-handling machine of claim **13**, wherein the chain is connected to the carriage by a chain connector, the chain connector comprising:

a bracket having an opening for receiving the chain;

a fastening bolt movably connected to the bracket, the bolt having a first end external to the bracket, and a second end within the opening for selectively engaging and releasing the chain.

15. The pipe-handling machine of claim **2**, wherein the elongated trestle further comprises at least two first pipe-carrying arms for receiving a joint of pipe, the first pipe-carrying arms being disposed on a first side of the trestle.

16. The pipe-handling machine of claim **15**, wherein each of the pipe-carrying arms further comprises a hand for selectively receiving a joint of pipe, and for releasing the joint of pipe into the upper surface of the trough.

17. The pipe-handling machine of claim **15**, wherein the elongated trestle further comprises at least one stabilizing arm on the first side of the trestle.

18. The pipe-handling machine of claim **17**, wherein the at least one stabilizing arm further comprises a hand, the hand having a bottom concave surface for engaging a joint of pipe when the first pipe-carrying arms receive a joint of pipe.

19. The pipe-handling machine of claim **15**, wherein the elongated trestle further comprises at least Iwo second pipe-carrying arms for receiving a joint of pipe, the second pipe-carrying arms each being disposed on an a second opposite side of the elongated trestle.

20. The pipe-handling machine of claim **11**, wherein each of the at least two second pipe-carrying arms further comprises a hydraulically actuated hand for selectively receiving a joint of pipe from the upper surface of the elongated trough, and for releasing the joint of pipe.

21. The pipe-handling machine of claim 1, wherein the elongated trough further comprises at least two lifting plates within the upper concave surface of the elongated trough, the at least two lifting plates being movable from a first retracted position to a second extended position, the lifting plates being configured to receive a joint of pipe when in the retracted position, and to expel a joint of pipe to one side of the pipe-handling machine when in the extended position.

22. The pipe-handling machine of claim 21, wherein the at least two lifting plates are hydraulically actuated.

23. The pipe-handling machine of claim 1, wherein the elongated trough further comprises at least four lifting plates within the upper concave surface of the trough,

each of the at least four lifting plates being movable from a first retracted position to a second extended position,

each of the at least four lifting plates being configured to receive a joint of pipe when in the retracted position,

at least two of the lifting plates being configured to expel a joint of pipe to one side of the pipe-handling machine when in the extended position; and

at least two of the lifting plates being configured to expel a joint of pipe to a second opposite side of the pipe-handling machine when in the extended position.

24. The pipe-handling machine of claim 23, wherein the at least four lifting plates are hydraulically actuated.

25. The pipe-handling machine of claim 2, wherein the pivoting connection between the inclined ramp and the base is configured to permit the inclined ramp to be folded over the elongated trough.

26. The pipe-handling machine of claim 1, wherein the pipe-handling machine is dimensioned to be received upon and transported by a flat-bed trailer without necessity of a DOT permit.

27. A pipe-handling machine for manipulating joints of pipe at a rig site, the pipe-handling machine comprising:

a trough for receiving and supporting a joint of pipe along a longitudinal axis of the joint of pipe and configured to move with the joint of pipe toward a center of a rig floor;

a trough carrier for receiving the trough and along a longitudinal axis of the trough and configured to support a majority of the trough, wherein the trough carrier is configured to move to a unloading position wherein a portion of the trough carrier is above the rig floor;

a trestle for receiving the trough carrier, the trestle having a first end and a second end;

a ramp having a lower end and an upper end, the ramp pivotally connected to the first end of the trestle;

a hydraulically operated trestle transport mechanism for transporting the first end of the trestle between the upper and lower ends of the ramp;

a hydraulically operated trough transport mechanism for slidably moving the trough axially along the trough carrier and configured to extend the trough beyond the end of the trough carrier when the trough carrier is in the unloading position; and

a hydraulic control system.

28. The pipe-handling machine of claim 27, wherein:

the trestle further comprises at least two pipe-carrying arms for receiving a joint of pipe, the pipe-carrying arms being disposed on an a side of the trestle; and

the pipe-carrying arms are actuated by the hydraulic system.

29. The pipe-handling machine of claim 27, wherein: the trough further comprises at least two lifting plates, the at least two lifting plates being movable from a first retracted position to a second extended position, the lifting plates being configured to receive a joint of pipe when in the retracted position, and to expel a joint of pipe to one side of the pipe-handling machine when in the extended position; and

the at least two lifting plates are actuated by the hydraulic system.

30. The pipe-handling machine of claim 27, wherein:

the trough further comprises at least four lifting plates within the upper concave surface of the trough,

each of the at least four lifting plates being movable from a first retracted position to a second extended position,

each of the at least four lifting plates being configured to receive a joint of pipe when in the retracted position,

at least two of the lifting plates are configured to expel a joint of pipe to one side of the pipe-handling machine when in the extended position;

least two of the lifting plates are configured to expel a joint of pipe to a second opposite side of the pipe-handling machine when in the extended position; and

each of the at least four lifting plates is actuated by the hydraulic system.

31. The pipe-handling machine of claim 29, further comprising a trough carrier transport mechanism for moving the trough carrier relative to the trestle.

32. The pipe-handling machine of claim 31, wherein the hydraulic control system is configured such that:

actuation of the trough transport mechanism and the trough carrier transport mechanism is locked out when the first end of the trestle transport mechanism reaches a point along the ramp proximate to the lower end of the ramp; and

actuation of the at least two lifting plates is locked out when the first end of the trestle transport mechanism reaches a point along the ramp proximate to the upper end of the ramp.

33. The pipe-handling machine of claim 1, wherein the second end of the elongated trough carrier is capable of being lifted above the upper surface of the elongated trestle.

34. The pipe-handling machine of claim 28, wherein the trough is configured to be movable relative to the trough carrier.

35. The pipe-handling machine of claim 34, wherein the trough carrier is configured to be axially movable relative to the trestle.

36. The pipe-handling machine of claim 35, wherein the trough carrier is configured to be rotationally movable relative to the trestle.

37. A pipe-handling machine for manipulating joints of pipe at a rig site, the pipe-handling machine comprising:

a pipe tray configured to support the majority of a joint of pipe along a longitudinal axis of the pipe;

a first elongated frame configured to support a majority of the pipe tray as the pipe tray travels longitudinally along a longitudinal axis of the first elongated frame;

a second elongated frame configured to receive the first elongated frame, the second elongated frame having a first end and a second end;

a ramp along which the second elongated frame rides, the ramp being inclined in the direction of a wellbore operation platform;

a first actuator for extending the second elongated frame to a location proximate the wellbore operation platform when the first end of the second elongated frame is delivered along the ramp to a position above an elevation of the wellbore operation platform;

a second actuator configured to lift the second end of the first elongated frame relative to the second end of the second elongated frame thereby reducing the angle of approach of the first elongated frame to the wellbore operation platform when the first end of the second elongated frame is delivered along the ramp to the position above an elevation of the wellbore operation platform, wherein the first elongated frame in configured to be above the wellbore operation platform; and

a third actuator configured to move the pipe tray along a longitudinal axis of the first elongated frame thereby delivering the pipe tray and the joint of pipe of a position above a wellbore.

38. The pipe handling machine of claim **37**, wherein the second actuator pivots the first elongated frame relative to the ramp.

39. The pipe-handling machine of claim **1**, further comprising a ramp actuator configured to pivot the inclined ramp to a position over the elongated trestle.

40. The pipe-handling machine of claim **4**, wherein the first end of the elongated trough carrier is configured to move to a position above a rig floor when the trough carrier is in an unloading position for unloading the joint of pipe to the rig site.

41. The pipe-handling machine of claim **40**, wherein the trough transport mechanism is configured to move the first end of the elongated trough toward a center of the rig floor beyond the first end of the elongated trough carrier when the trough carrier is in the unloading position, thereby moving the joint of pipe near the center of the rig floor.

42. The pipe-handling machine of claim **27**, further comprising a ramp actuator configured to pivot the ramp between a retracted position and an extended position relative to the trestle, wherein in the retracted position the ramp is located above the trestle for shipment of the pipe-handling machine.

43. The pipe-handling machine of claim **37**, further comprising a ramp actuator configured to move the ramp between a retracted position and an extended position relative to the second elongated frame, wherein in the retracted position the ramp is located above the second elongated frame for shipment of the pipe-handling machine.

44. The pipe-handling machine of claim **43**, further comprising a modular ramp sections configured to extend and retract the length of the ramp in order to adapt to the height of the wellbore operation platform.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,404,697 B2
APPLICATION NO. : 10/513543
DATED : July 29, 2008
INVENTOR(S) : Thompson

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 22, Claim 19, Line 59, please delete “Iwo” and insert --two-- therefor;

Column 24, Claim 30, Line 15, please insert --at-- before “least”.

Signed and Sealed this

Tenth Day of February, 2009

John Doll

JOHN DOLL
Acting Director of the United States Patent and Trademark Office